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PROPELLANT SURVEILLANCE REPORT LGM-30 A, B, F & G STAGE I TP-H1--ETC(U)
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OGDEN AIR LOGISTICS CENTER

UNITED STATES AIR FORCE

PROPELLANT SURVEILLANCE REPORT LGM-30A, B, F & G STAGE I TP-H 1043

PROPELLANT LAB SECTION

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LGM-30 A, B, F & G STAGE I

TP-H1043 AFT CLOSURE PROPELLANT

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ABSTRACT

This report contains propellant test results from cartons of TP-H1043 propellant representing selected batches used in the aft closure of First Stage Minuteman Motors. Data from TP-H1043 propellant obtained from the aft closures of the LGM-30 A, B, F, and G Motors are reported in regression analyses for the sixth time and the fifth time using the G085 Computer System. In previous reports, A, B, F, and G data were combined for statistical analysis. For this report, a separate statistical analysis was made for A and B (wing 2) and F and G (wing 6). The statistical analysis includes regressions and covariance analysis. Testing was accomplished in accordance with MMWRBA Project M8293C.

An analysis of all parameters indicate that no significant degradation is anticipated for at least two years past the oldest data point.

Each point on the regression plot represents all samples at that particular age. The number of samples at each point is indicated on the sample size summary sheet on the page accompanying each regression plot. The data range at any age can be found by suitable inquiry of the G085 System.

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LIST OF REFERENCES

Report Nr	Title	Report Date
	LGM-30 First Stage, Wing I Test Reports	
29D	Zero Time Test Results (Aft Closure)	9 Jun 64
29E	Zero Time (Aft Closure Supplement 1)	24 Jun 64
32B	Zero Time, Wings II-V Test Results (Aft Closure)	18 Mar 65
185	ATP Phase I, Wing VI Series III	Jun 70
195	ATP Phase III, Wing II-V	Nov 70
239	Propellant Surveillance Report (TP-H1043)	Apr 72
288	Propellant Surveillance Report (TP-H1043)	Mar 74
337	Propellant Surveillance Report (TP-H1043)	Feb 76
385	Propellant Surveillance Report (TP-H1043)	Dec 77
424	Propellant Surveillance Report (TP-H1043)	Nov 79

GLOSSARY OF TERMS AND ABBREVIATIONS

Aging Trend	A change in properties or performance resulting from aging of material or component
CSA	Cross Sectional Area
DB	Dogbone
Degradation	Gradual deterioration of properties or performance
E	Modulus (psi), defined as stress divided by strain along the initial linear portion of the curve
EB	End Bonded
EGL	Effective Gage Length
em	Strain at maximum stress
er	Strain at rupture
"F" ratio	The ratio of the variance accounted for by the regression function to the random unexplained variance. The regression function having the most significant "F" ratio is used for plotting data. The ratio is also used in detecting significant changes in random variation between succeeding time points.
JANNAF	Joint Army, Navy, NASA, Air Force Committee
MAGCP	Propellant Lab Section at OOAMA
OOAMA	Ogden Air Materiel Area, Air Force Logistics Command
Regression Equation	The general form of the regression equation is $Y = a + bx$
Regression Line	Line representing mean test values with respect to time
S_b	Standard error of estimate of the regression coefficient
S_e or $S_{Y.X}$	Standard deviation of the data about the regression line

GLOSSARY OF TERMS AND ABBREVIATIONS (cont)

SM	Maximum Stress
Sr	Stress at rupture
Standard Deviation(S)	Square root of variance
Strain Rate	Crosshead speed divided by the EGL
"t" test	A statistical test used to detect significant differences between a measured parameter and an expected value of the parameter (determines if regression slope differs from zero at the 95% confidence level)
Variance	The sum of squares of deviations of the test results from the mean of the series after division by one less than the total number of test results
3 Sigma Band	The area between the upper and lower 3 sigma limit. It can be expected that 99.73% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed.
90-90 Band	It can be stated with 90% confidence that 90% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed.

INTRODUCTION

A. PURPOSE:

Quality assurance tests have been conducted for 14 1/2 years on First Stage LGM-30 TP-H1043 aft closure propellant.

Statistical analysis of the tests performed, as directed by Engineering, should provide early warning if serious degradation trends occur. Evaluation of the propellant provides data that can be put directly into engineering reliability and service life predictions. Testing was performed in accordance with MMWRBA Directive GTD-1C, Amendments 1 and 2.

B. BACKGROUND:

TP-H1043 propellant is used in the aft closure of the LGM-30 A, B, F, and G First Stage Motors.

This test period represents the sixth time that TP-H1043 propellant has been reported by regression analysis. This is also the fifth time that data has been processed utilizing the G085 System.

C. SAMPLING PLAN:

As many as four aft closures are cast from the one TP-H1043 propellant mix. In order to reduce the number of tests, only one batch from each mix will be tested to obtain uniform test results. The selected batches are from the same batch as those previously tested and reported in MANCP Reports 185(70), 195(70), 239(72), 288(74), 385(77), and 424(79).

Low rate tensile, high rate tensile and hardness tests were performed on each propellant batch mix.

STATISTICAL ANALYSIS

Analysis of covariance was selected as a method of statistically comparing regression trend lines from wing 2 and wing 6 data. Although both groups of data are from the same population, they have undergone unknown biasing and will be handled separately. This was discovered during the analysis of covariance test. Therefore, these two groups of data will no longer be statistically placed in the same regressions.

Linear regression analysis was selected as the method for data evaluation. Data from different time periods were used to establish a least squares trend line for the data. The variance about the regression line, obtained using individual values of the dependent variable, was used to compute a tolerance interval such that at the 90% confidence level, 90% of the sample distribution fall within this interval. This tolerance interval was extrapolated to a maximum of 24 months. The "t" values and the significance of this statistic, which are reported for each regression model, give an indication of the "statistical significance" of the slope of the trend line as compared to a line of zero slope.

Each point on the regression analysis is a calculation of all samples at that particular age. The number of samples at each point is indicated on the sample size summary sheet accompanying each regression plot. The data range at any age can be found by suitable inquiry of the G085 System.

The analysis of covariance uses lower experimental error and a more precise comparison among treatments (wings). The regressions may differ in slope direction, elevation, or in residual variances. The most convenient approach is to compare the residual variance first, then the

slopes, and lastly the elevations. The residual mean squares are compared by the two-tailed F-test at the 5% significant level. The null hypothesis that Wing 2 and Wing 6 population residual variances are statistically equal must be rejected in all comparisons. The scatter of the points about the individual regression lines suggests that the differences in slope and elevation may be attributed to sampling variations.

The slight difference in slope and trend directions found in Wing 2 and Wing 6 data are mostly due to differences in sample quantities and number ot test periods represented. However, all regression slopes are statistically close to a linear line of zero slope regardless of the direction. Additional Wing 6 testing should provide the required number of samples which should provide compatability with the Wing 2 test results.

TEST RESULTS

A. LOW RATE TENSILE:

The strains at maximum stress for wing two and wing six regressions (Fig 1 and 2), show a statistically significant decreasing slope. The analysis of covariance (Table 2), shows a statistically significant difference in variance and elevation with no significant difference in slope.

For maximum stress the wing two regression shows a statistically decreasing slope and the wing six regression shows a non-significant slope (Fig 3 and 4). The analysis of covariance shows a statistically significant difference for variance, slope, and elevation (Table 3).

The strain at rupture, for wing 2, shows a statistically significant increasing slope with a statistically significant decreasing slope for the wing six regression (Fig 5 and 6). The analysis of covariance shows a statistically significant difference for variance, slope, and elevation (Table 4).

The stress at rupture regression for wing two shows a statistically significant decreasing slope with a non-significant slope for wing six (Fig 7 and 8). The analysis of covariance shows a statistically significant difference for variance, slope, and elevation (Table 5).

Modulus regressions show a statistically significant decreasing slope for wing two and a non-significant slope for wing six (Fig 9 and 10). The analysis for covariance shows a statistically significant difference for variance, slope, and elevation (Table 6).

B. HIGH RATE TENSILE:

The strain at maximum stress regression for wing two shows a statistically significant decreasing slope and the wing six regression shows a statistically significant increasing slope (Fig 11 and 12). The analysis of covariance shows a statistically significant difference for variance, slope, and elevation (Table 7).

The maximum stress regression shows a statistically significant decreasing slope, with wing six regression showing a statistically significant increasing slope (Fig 13 and 14). The analysis for covariance shows a statistically significant difference for variance and slope with no significant difference for elevation (Table 8).

Strain at rupture regressions show a statistically significant decreasing slope for wing two and a statistically significant increasing slope for wing six (Fig 15 and 16). The analysis for covariance shows a statistically significant difference for variance, slope, and elevation (Table 9).

Stress at rupture regressions shows a statistically non-significant slope for wing two and wing six (Fig 17 and 18). The analysis for covariance shows a statistically significant difference for variance, slope, and elevation (Table 10).

Modulus regressions show a statistically significant increasing slope for wing two and a statistically significant decreasing slope for wing six (Fig 19 and 20). The analysis for covariance shows a statistically significant difference for variance, slope, and elevation (Table 10).

C. HARDNESS:

Shore A initial hardness regressions for wing two and wing six show statistically significant increasing slopes (Fig 21 and 22). The analysis for covariance shows a statistically significant difference for variance, slope, and elevation (Table 11).

Shore A ten second hardness regressions show a statistically significant increasing slope for wing two and a statistically significant decreasing slope for wing six (Fig 23 and 24). The analysis for covariance

shows a statistically significant difference for variance and slope with no difference for elevation (Table 12).

Shore C initial hardness regression shows a statistically significant decreasing slope for wing two and wing six (Fig 25 and 26). Analysis for covariance shows a statistically significant difference for variance and elevation with no difference for slope (Table 13).

Shore C ten second hardness regressions show a statistically significant decreasing slope (Fig 27 and 28). Analysis for covariance shows a statistically significant difference for variance, slope, and elevation (Table 14).

CONCLUSIONS AND RECOMMENDATIONS

Wing two and wing six data cannot be combined for statistical analysis.

For both wing two and wing six, the slopes of the regressions are gradual and close to a line of zero slope. From this analysis, the propellant degradation is gradual and the propellant service life may be extended for at least two years beyond the date of the last testing.

It is recommended that testing be continued to assure service life extension and confirm present trends.

TABLE 1
ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSIONS AT THE 5 % SIGNIFICANT LEVEL

** TYPE ** TEST		** REGRESSIONS ** VARIANCE	SLOPE	ELEVATION
TENSILE -- LOW RATE --				
	strain at max stress	S.	N.S.	S.
	max stress	S.	S.	S.
	strain at rupture	S.	S.	S.
	stress at rupture	S.	S.	S.
	modulus	S.	S.	S.
-- HIGH RATE --				
	strain at max stress	S.	S.	S.
	max stress	S.	S.	N.S.
	strain at rupture	S.	S.	S.
	stress at rupture	S.	S.	S.
	modulus	S.	S.	S.
HARDNESS -- SHORE A --				
	initial	S.	S.	S.
	10-sec.	S.	S.	N.S.
-- SHORE C --				
	initial	S.	N.S.	S.
	10-sec.	S.	S.	S.

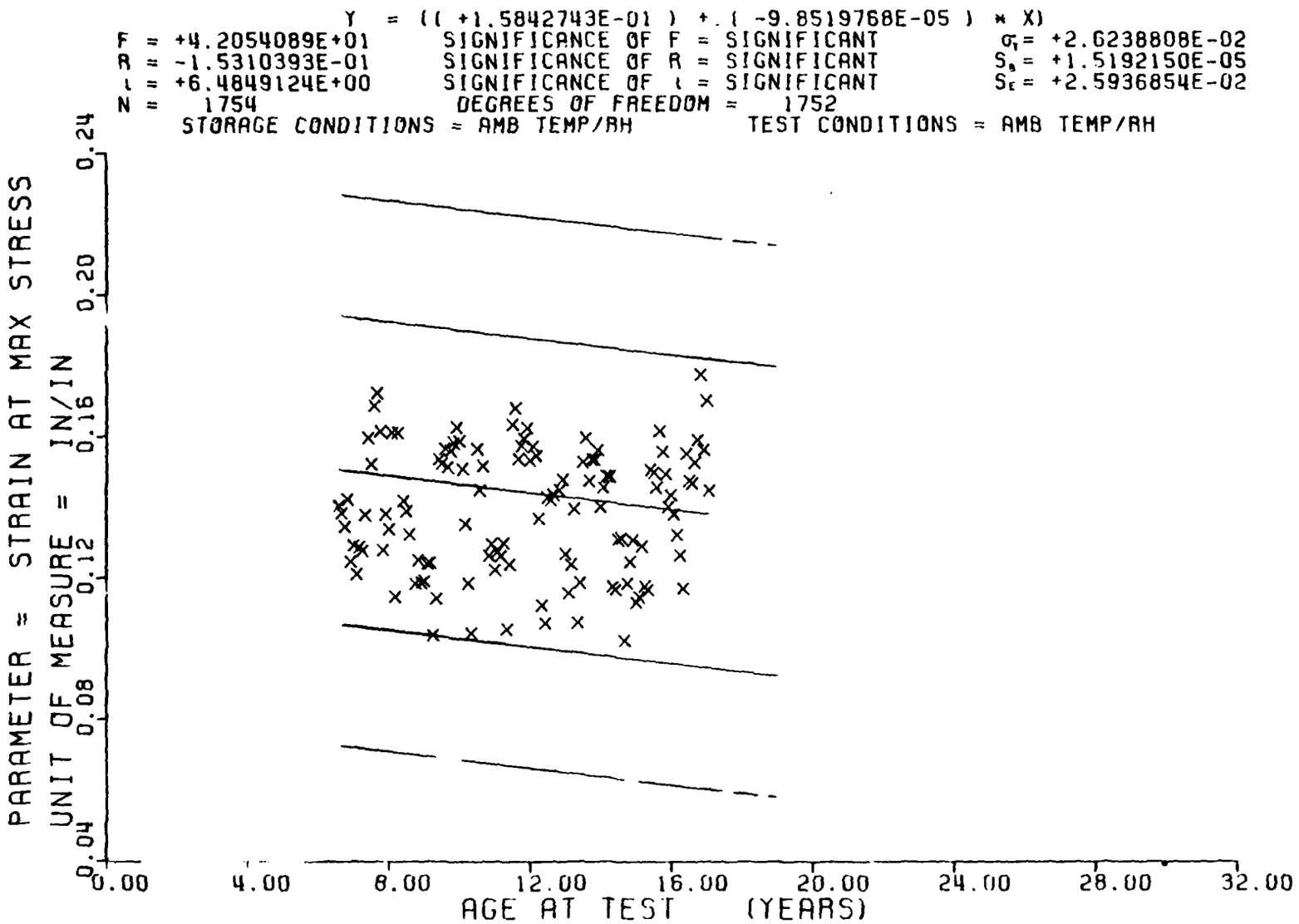
N.S.=Not significantly different
S. =Significantly different

*** SAMPLE SIZE SUMMARY ***

AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP
79	5	106	3	133	12	159	8	184	21
80	3	107	6	134	3	160	6	185	19
81	12	108	12	135	6	161	12	186	11
82	3	109	9	136	9	162	9	187	18
83	9	110	6	137	12	163	6	188	12
84	9	111	6	138	9	164	9	189	15
85	10	112	12	139	9	165	9	190	24
86	25	113	9	140	12	166	12	191	21
87	18	114	12	141	12	167	17	192	27
88	27	115	6	142	12	168	6	193	22
89	39	116	12	143	14	169	10	194	9
90	64	117	9	144	9	170	12	195	23
91	143	118	23	145	12	171	3	196	18
92	144	119	3	146	12	172	12	197	9
93	54	120	15	147	6	173	12	198	6
94	33	121	21	148	9	174	3	199	6
95	33	122	3	149	6	175	9	200	9
96	27	123	12	150	6	176	3	201	6
97	3	124	9	151	3	177	6	202	17
98	3	125	6	152	12	178	6	203	12
99	6	127	3	154	6	179	6	204	15
101	6	128	12	155	6	180	6	205	13
102	9	130	9	156	9	181	9		
103	9	131	6	157	12	182	3		
105	6	132	6	158	12	183	5		

STAGE 1, WING 2, TP-H1043, STRAIN AT MAX STRESS, LOW RATE, CHS=2.0

This sample size summary is applicable to figure 1, 3, 5, 7, and 9



STAGE 1, WING 2, TP-H1043, STRAIN AT MAX STRESS, LOW RATE, CHS=2.0

Figure 1

*** SAMPLE SIZE SUMMARY ***

AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP
57	3	109	24	147	12
59	9	110	18	148	15
60	3	111	27	149	12
61	6	112	15	150	5
62	9	113	24	152	3
63	6	114	14	181	5
64	3	115	9	182	3
65	6	128	3	183	1
66	9	129	3	185	2
67	6	130	6	188	3
69	3	131	15		
92	6	132	26		
93	6	133	20		
94	30	134	30		
95	18	135	17		
96	6	136	18		
97	15	137	21		
98	3	138	18		
99	18	139	3		
90	3	141	3		
91	3	142	6		
104	3	143	30		
106	3	144	30		
107	12	145	18		
108	21	146	24		

STAGE 1, WING 6, TP-H1043, STRAIN AT MAX STRESS, LOW RATE, CHS=2.0

This sample size summary is applicable to figure 2, 4, 6, 8, and 10

Y = ((+1.3280526E-01) + (-4.5849890E-05) * X)

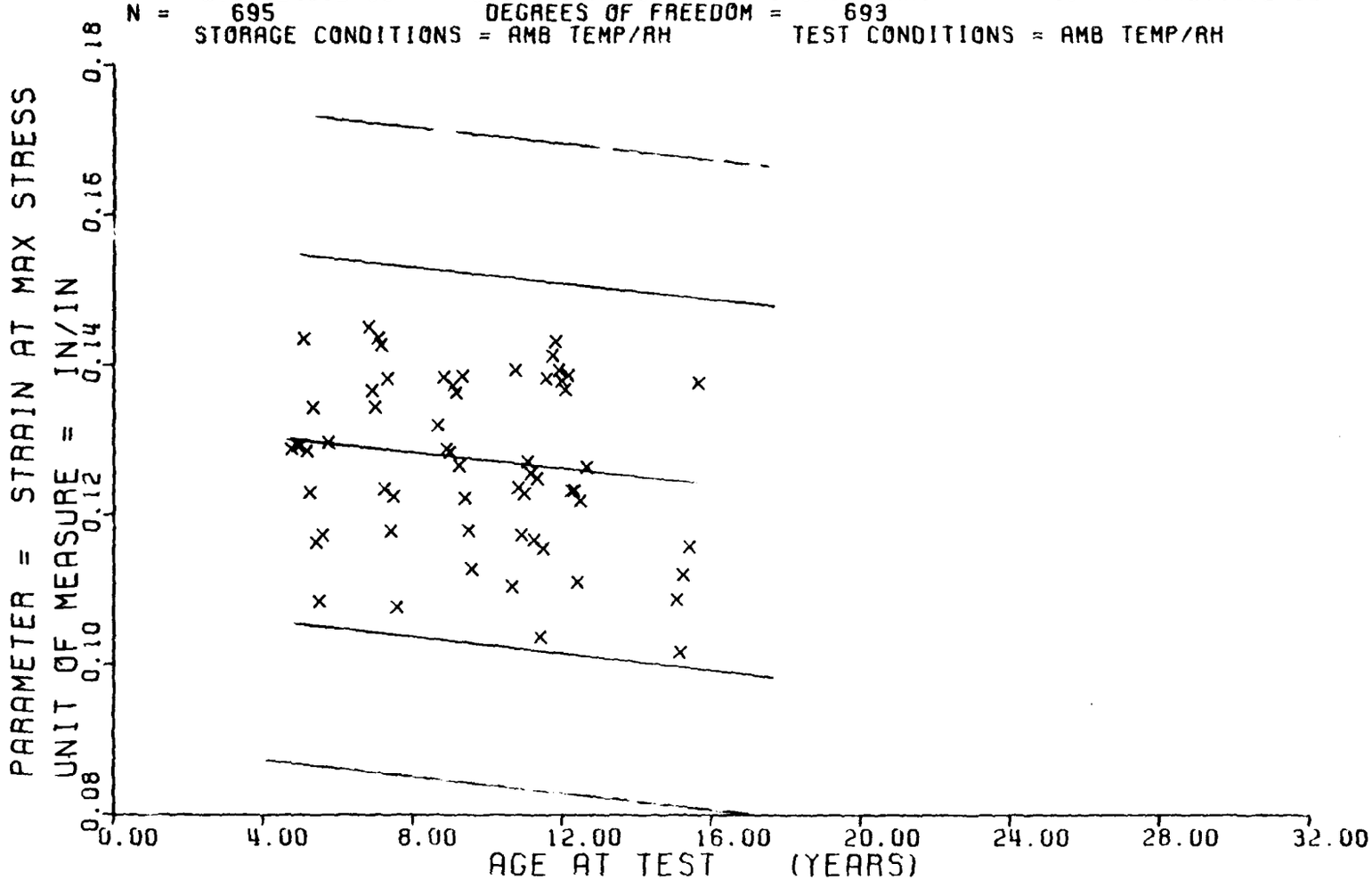
F = +5.4767541E+00 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +1.4474361E-02

R = -8.8549404E-02 SIGNIFICANCE OF R = SIGNIFICANT S_B = +1.9591905E-05

t = +2.3402466E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +1.4427901E-02

N = 695 DEGREES OF FREEDOM = 693

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, STRAIN AT MAX STRESS, LOW RATE, CHS=2.0

Figure 2

TABLE 2

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVARIANCE,COMPARES REGRESSIONS,TP=H104,,CDS=2,0,STND MAX STEP,W=.76

SOURCE	D.F.	CORRELATED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN								
SMS2LP	1752	0.27147E+07	-287.16	1.2[illegible]	-0.[illegible]520E-04	1752	1.1786	0.67272E-03
SMS6LP	693	0.54632E+06	-24.366	0.14946	-0.[illegible]853E-04	693	0.14921	0.21716E-03
						2445	1.3229	0.54105E-03
POOLED	2457	0.34570E+07	-312.06	1.3[illegible]23	-0.[illegible]257E-04	2446	1.3241	0.54135E-03
DIFFERENCE BETWEEN SLOPES						1	0.12275E-06	0.12279E-03
BETWEEN	1	77344.	11.31	0.18927				
TOTAL	2446	0.25344E+07	-199.21	1.5107		2447	1.5056	
TEST FOR PARALLELISM						1	0.10150	0.10150

STEP 3:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 3.23(DF=1752, 693) STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS NOT CONFIRMED WITH STEP 2.
STEP 4:
COMPARISON OF REGRESSION TREND LINE SLOPES : F= 2.24(DF= 1,2445) NOT STATISTICALLY DIFF.
COMPARISON OF REGRESSION TREND LINE ELEVATIONS : F= 245.27(DF= 1,2446) STATISTICALLY DIFF.

Y = ((+1.9440499E+02) + (-2.1261750E-01) * X)

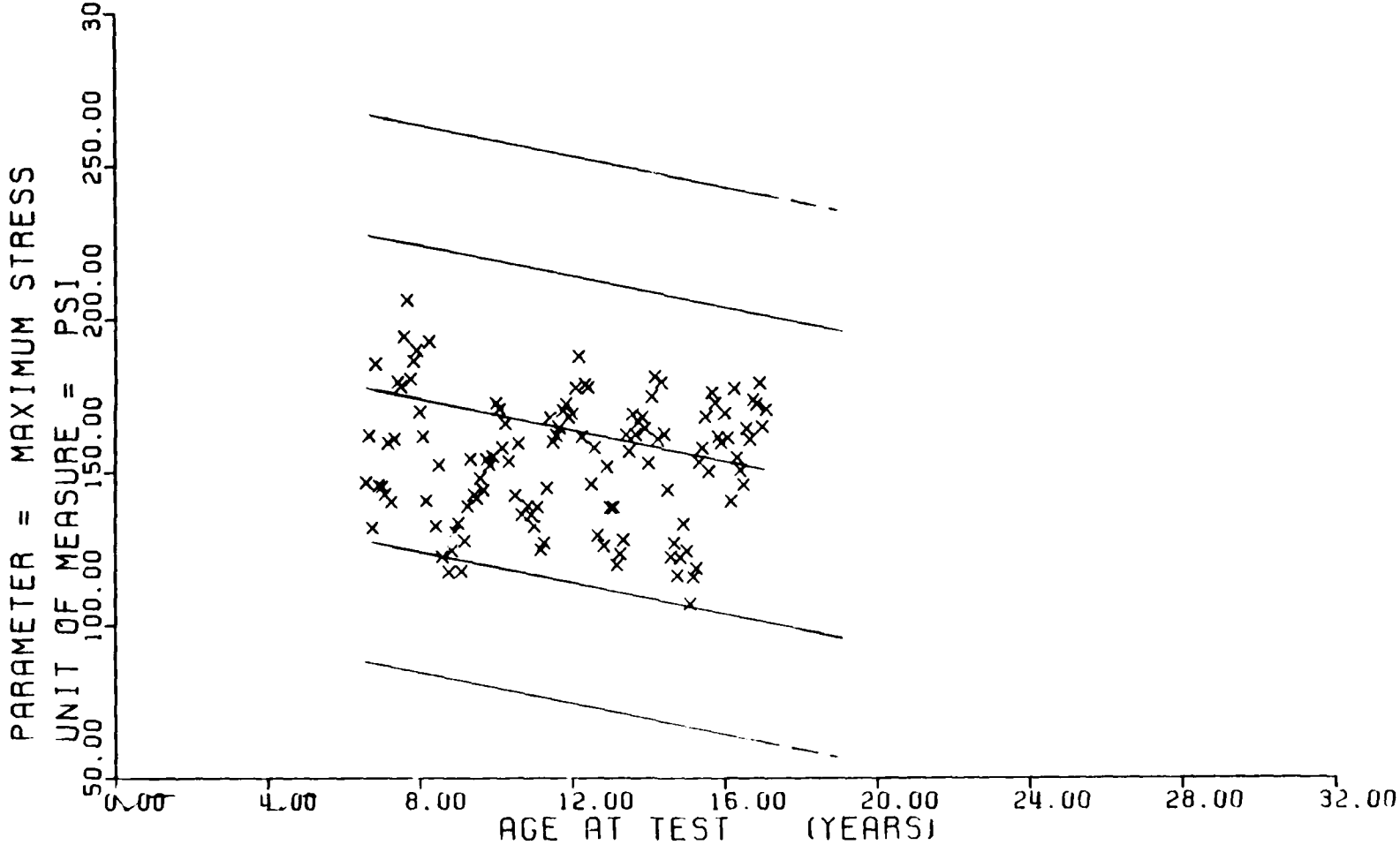
F = +1.4901312E+02 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +3.0974085E+01

R = -2.7990167E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +1.7417537E-02

t = +1.2207093E+01 SIGNIFICANCE OF t = SIGNIFICANT S_E = +2.9744490E+01

N = 1755 DEGREES OF FREEDOM = 1753

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, MAXIMUM STRESS, LOW RATE, CHS=2.0

Figure 3

Y = ((+1.6082944E+02) + (-4.1645404E-02) * X)

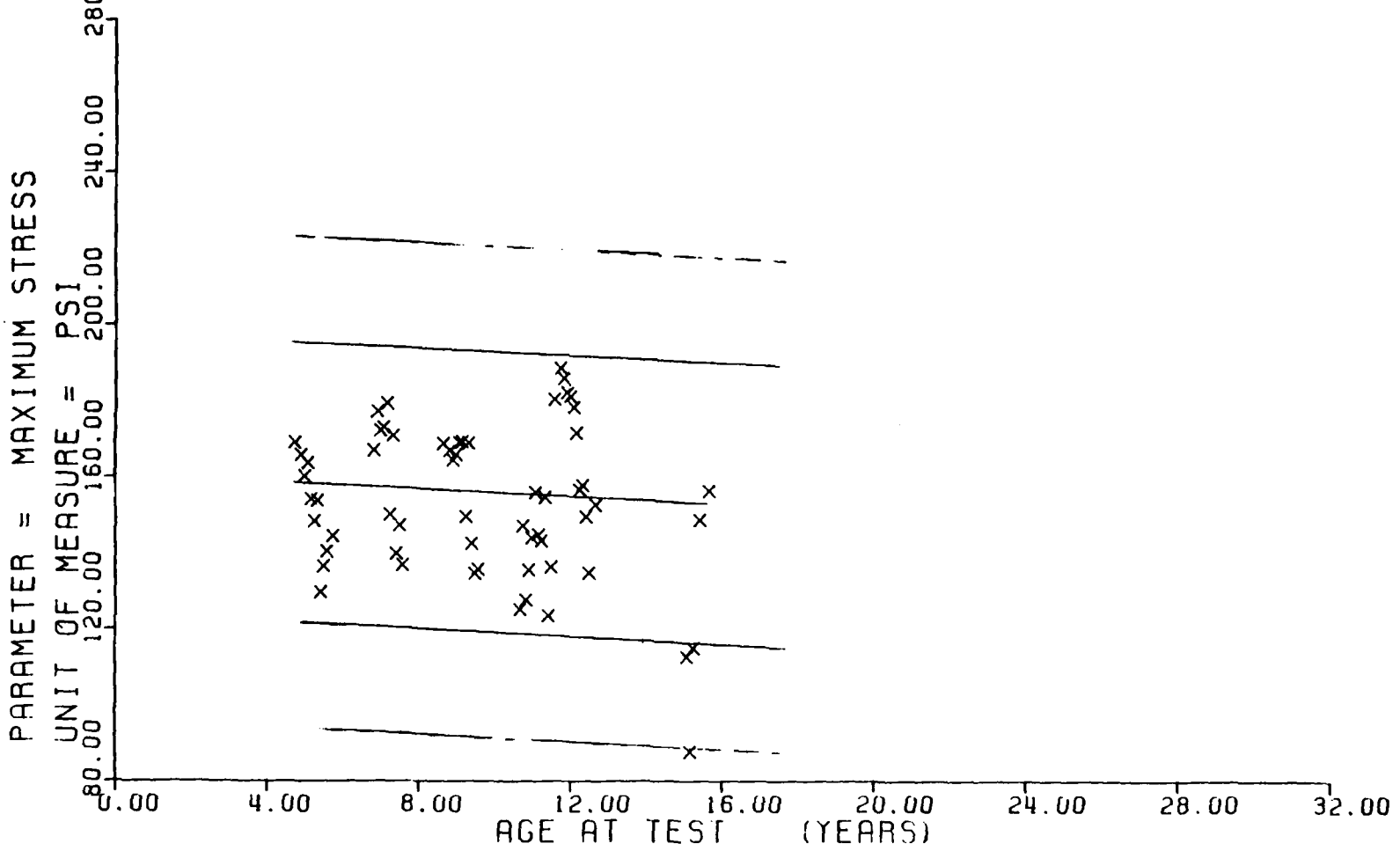
F = +2.0298814E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ_Y = +2.1541712E+01

R = -5.4042272E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S_B = +2.9230196E-02

t = +1.4247390E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT S_E = +2.1525746E+01

N = 695 DEGREES OF FREEDOM = 693

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, MAXIMUM STRESS, LOW RATE, CHS=2.0

Figure 4

TABLE 3

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVARIANCE,COMPARES REGRESSIONS,TP=H104,CES=2,0,MAX STRESS,KING=276

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN								
MXS2LP	1754	0.29165E+07	-0.62007E+06	0.16[illegible]0E+07	-0.21262	1753	0.15504E+07	884.74
MXS6LP	694	0.5923[illegible]E+0[illegible]	-22497.	0.5[illegible]E+06	-0.41[illegible]4E-01	693	0.32135E+06	463.71
						2446	0.1[illegible]72[illegible]E+07	7[illegible].45
POOLED	2448	0.34587E+07	-0.64256E+06	0.2[illegible]E+07	-0.1857[illegible]	2447	0.10857E+07	770.61
DIFFERENCE BETWEEN SLOPES						1	13592.	13592.
BETWEEN	1	77156.	66656.	57[illegible].				
TOTAL	2449	0.35357E+07	-0.57591E+06	0.2[illegible]E+07		2446	0.15[illegible]E+07	
BETWEEN ADJUSTED MEANS						1	83[illegible]52.	83[illegible]52.

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 1.91(DF=1753, 693) — STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION TREND LINE SLOPES : F= 17.50(DF= 1,2446) — STATISTICALLY DIFF.
COMPARISON OF REGRESSION TREND LINE ELEVATIONS : F= 100.05(DF= 1,2447) — STATISTICALLY DIFF.

Y = ((+2.7902915E-01) + (+5.6128604E-05) * X)

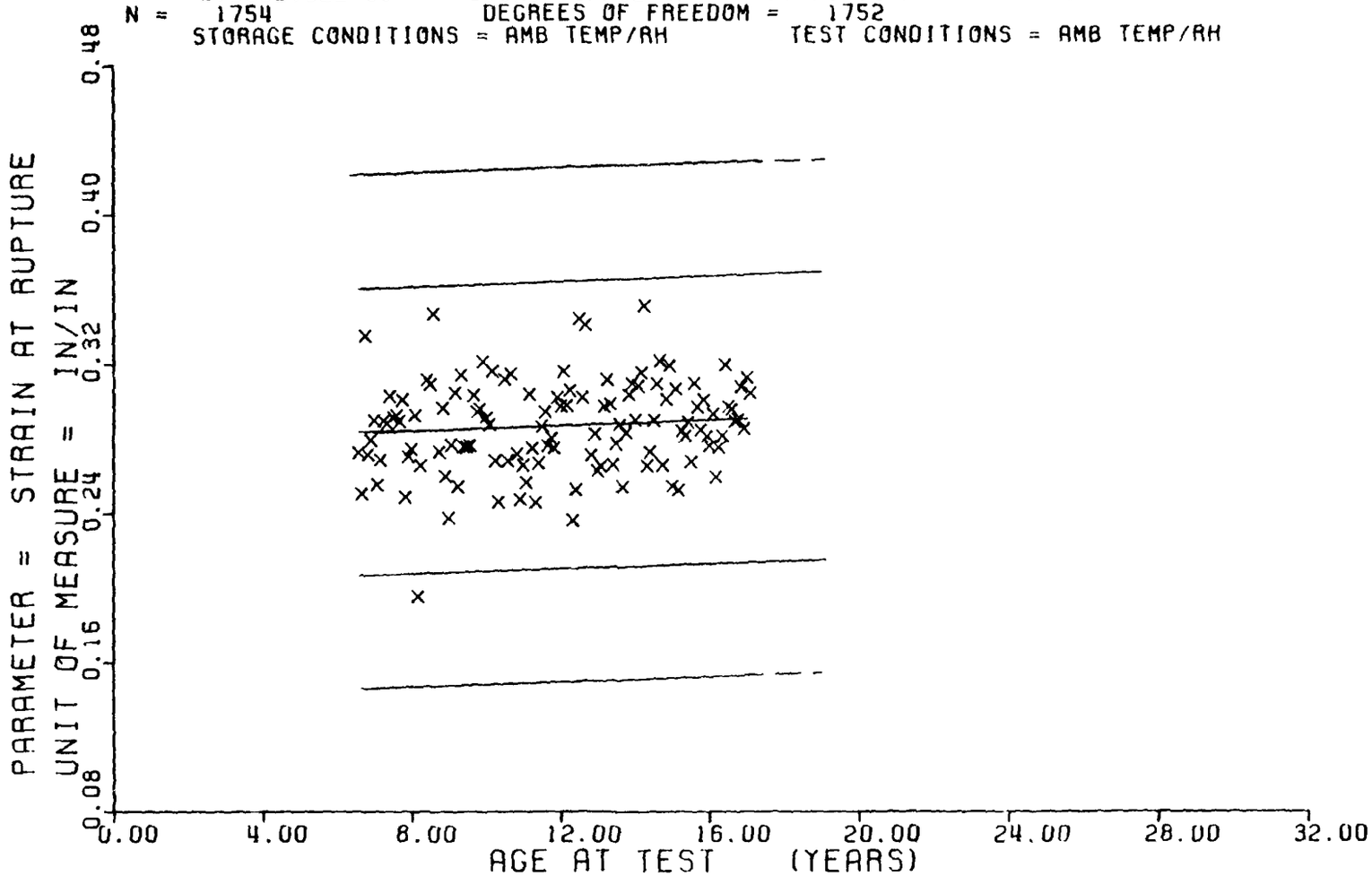
F = +4.3818054E+00 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +4.5822020E-02

R = +4.9947882E-02 SIGNIFICANCE OF R = SIGNIFICANT S_b = +2.0813758E-05

t = +2.0932762E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +4.5777885E-02

N = 1754 DEGREES OF FREEDOM = 1752

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, STRAIN AT RUPTURE, LOW RATE, CHS=2.0

Figure 5

Y = ((+3.2906807E-01) + (-1.4962635E-04) * X)

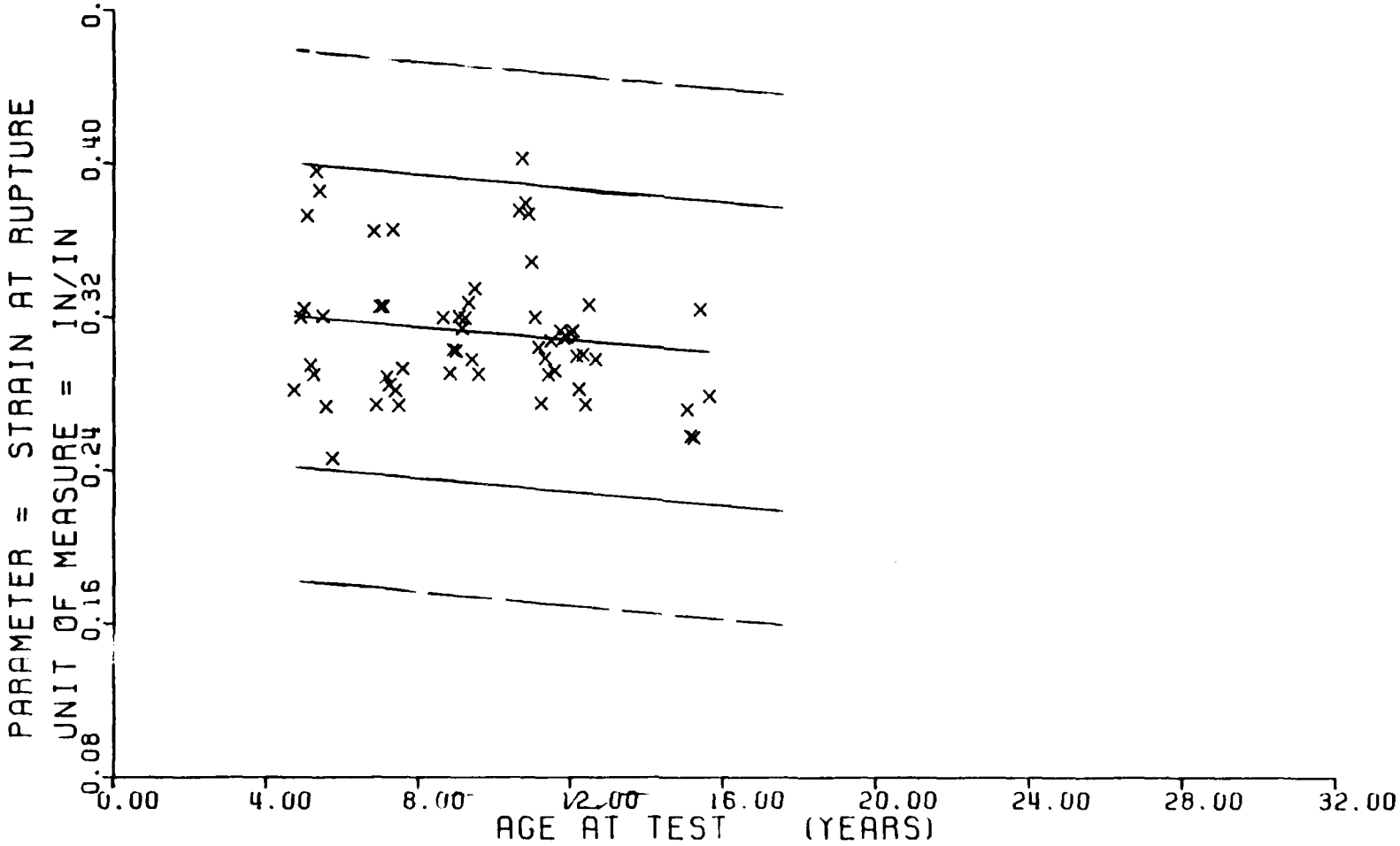
F = +5.7256720E+00 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +4.0205637E-02

R = -9.0523197E-02 SIGNIFICANCE OF R = SIGNIFICANT S_B = +6.2530927E-05

t = +2.3928376E+00 SIGNIFICANCE OF t = SIGNIFICANT S_t = +4.0049121E-02

N = 695 DEGREES OF FREEDOM = 693

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, STRAIN AT RUPTURE, LOW RATE, CHS-2.0

Figure 6

TABLE 4

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVARIANCE,COMPARES REGRESSIONS,TP=H164 ,CPS=2,0,STRC RUPTURE, K=276

SOURCE	D.F.	COMPLETE SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN								
SUP2LE	1755	0.29147E+07	165.66	3.5107	0.56129E-04	1752	3.0715	0.20956E-02
SUP6LE	694	0.5423[illegible]E+06	-61.144	1.4217	-0.14965E-03	693	1.4655	0.21205E-02
						2445	5.1411	0.21027E-02
POOLED	2447	0.3457[illegible]E+07	12.456	5.1[illegible]24	0.23852E-04	2446	5.1664	0.21097E-02
DIFFERENCE BETWEEN SLOPES						1	0.19556E-01	0.19356E-01
BETWEEN	1	77744.	-153.47	0.3[illegible]07				
TOTAL	2448	0.3[illegible]344E+07	-73.515	5.475[illegible]		2447	5.6757	
ERROR ADJUSTED MEANS						1	0.51333	0.51333

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F = 1.01(DF = 692,1752) — STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION FREE LINE SLOPES : F = 9.21(DF = 1,2445) — STATISTICALLY DIFF.
COMPARISON OF REGRESSION FREE LINE ELEVATIONS : F = 148.51(DF = 1,2446) — STATISTICALLY DIFF.

Y = ((+1.6590200E+02) + (-2.2459252E-01) * X)

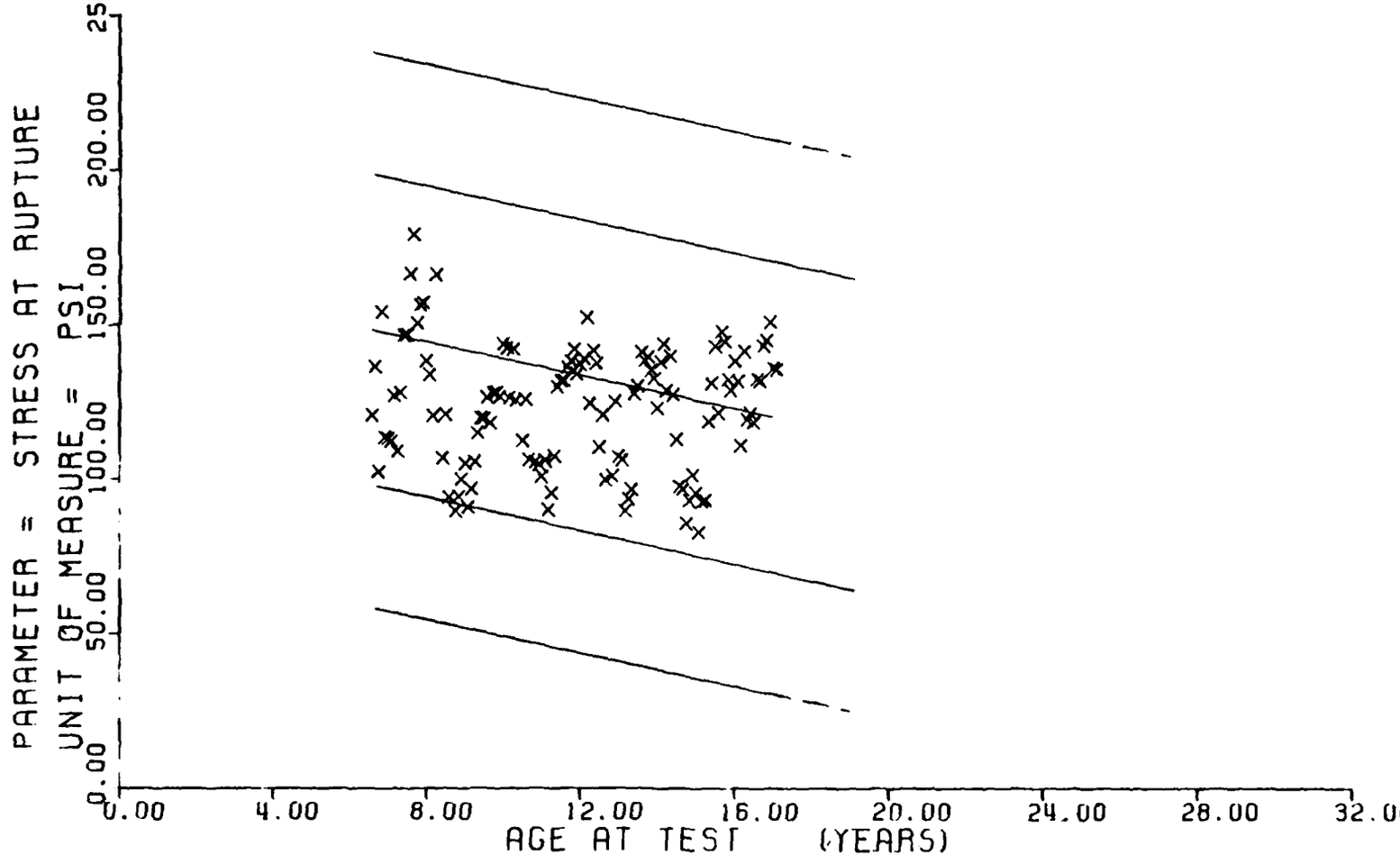
F = +1.6484712E+02 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +3.1236804E+01

R = -2.9317956E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +1.7492609E-02

t = +1.2839280E+01 SIGNIFICANCE OF t = SIGNIFICANT S_E = +2.9872694E+01

N = 1755 DEGREES OF FREEDOM = 1753

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, STRESS AT RUPTURE, LOW RATE, CHS=2.0

Figure 7

Y = ((+1.1935827E+02) + (+4.2891356E-02) * X)

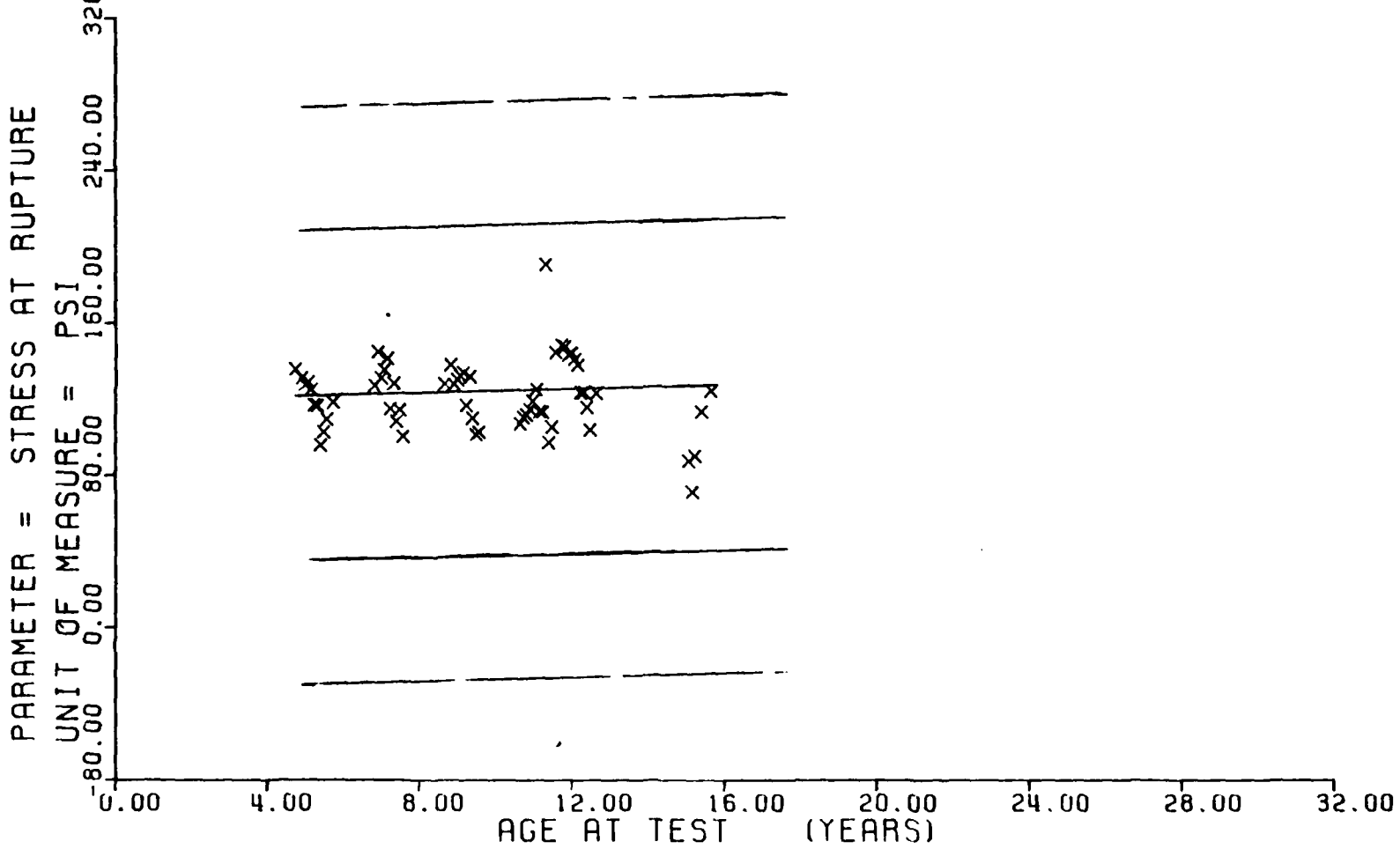
F = +3.9107742E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σ_Y = +5.0486385E+01

R = +2.3748831E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S_B = +6.8586463E-02

t = +6.2536183E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT S_E = +5.0508548E+01

N = 695 DEGREES OF FREEDOM = 693

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, STRESS AT RUPTURE, LOW RATE, CHS=2.0

Figure 8

TABLE 5

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVARIANCE,COMPARES REGRESSIONS,TP=H1043,CFS=2.0,STRS RUPTURE, W=276

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	DEVIATIONS FROM REGRESSION D.F.	SUM SQ.	MEAN SQ.
WITHIN								
SRP2LR	1754	0.29163E+07	-0.65499E+06	0.17114E+07	-0.22459	1753	0.15643E+07	892.38
SRP6LR	694	0.54232E+06	23261.	0.17069E+07	0.42691E-01	693	0.17679E+07	2551.1
						2446	0.33325E+07	1362.3
POOLED	2448	0.34587E+07	-0.65173E+06	0.34104E+07	-0.18265	2447	0.33650E+07	1375.1
			DIFFERENCE BETWEEN SLOPES			1	32717.	32717.
BETWEEN	1	77156.	75536.	74052.				
TOTAL	2449	0.35357E+07	-0.55619E+06	0.35944E+07		2448	0.34059E+07	
			BETWEEN ADJUSTED MEANS			1	0.10192E+06	0.10192E+06

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 2.86(DF= 693,1753) STATISTICALLY DIFF
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.
STEP 2:
COMPARISON OF REGRESSION TREND LINE SLOPES : F= 24.02(DF= 1,2446) STATISTICALLY DIFF
COMPARISON OF REGRESSION TREND LINE ELEVATIONS : F= 74.12(DF= 1,447) STATISTICALLY DIFF

Y = ((+2.8298920E+03) + (-3.7111880E+00) * X)

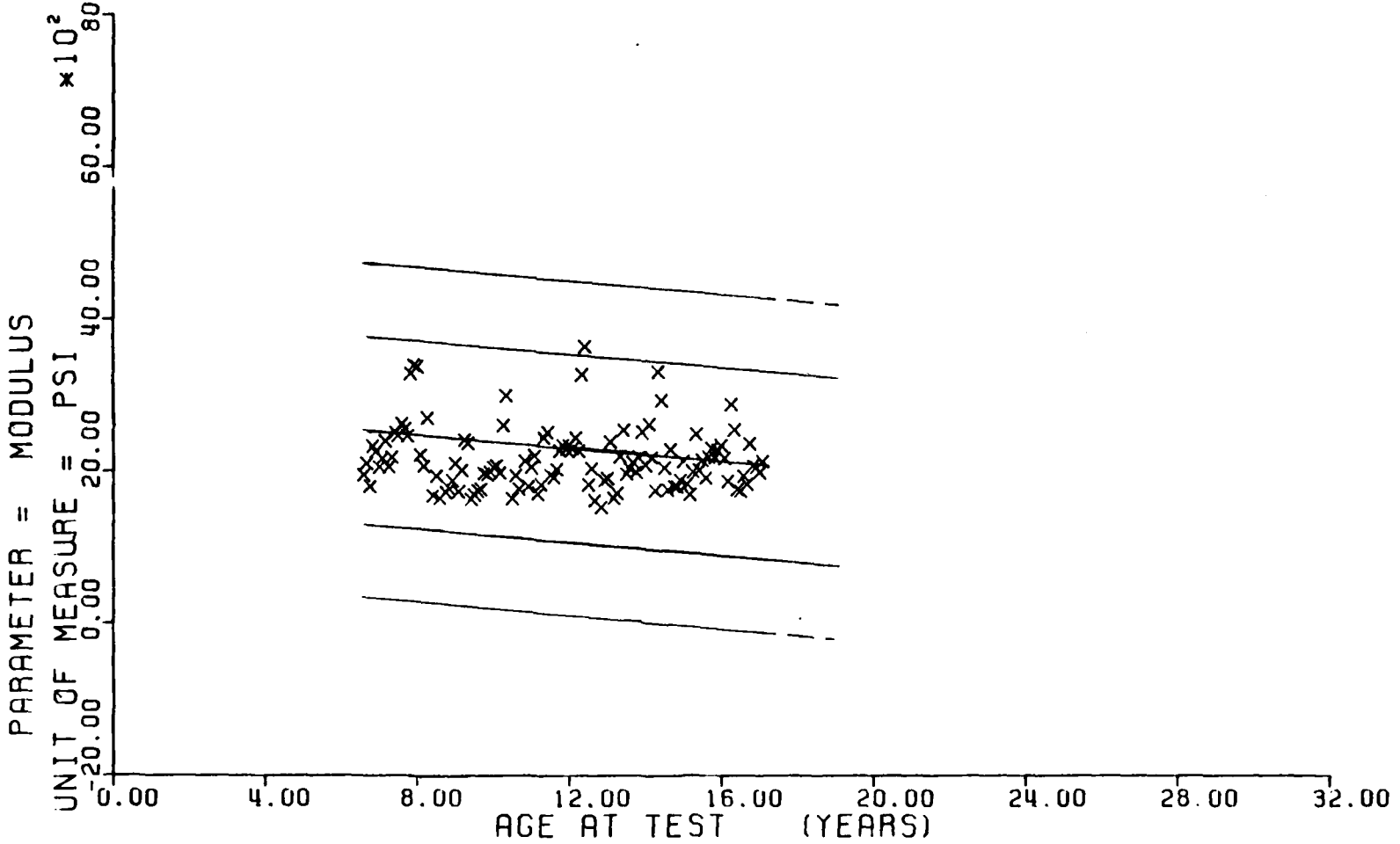
F = +7.4885681E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +7.4743998E+02

R = -2.0246208E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +4.2885804E-01

ι = +8.6536513E+00 SIGNIFICANCE OF ι = SIGNIFICANT S_E = +7.3216943E+02

N = 1754 DEGREES OF FREEDOM = 1752

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, MODULUS, LOW RATE, CHS=2.0

Figure 9

Y = ((+2.2911536E+03) + (-1.7806905E-01) * X)

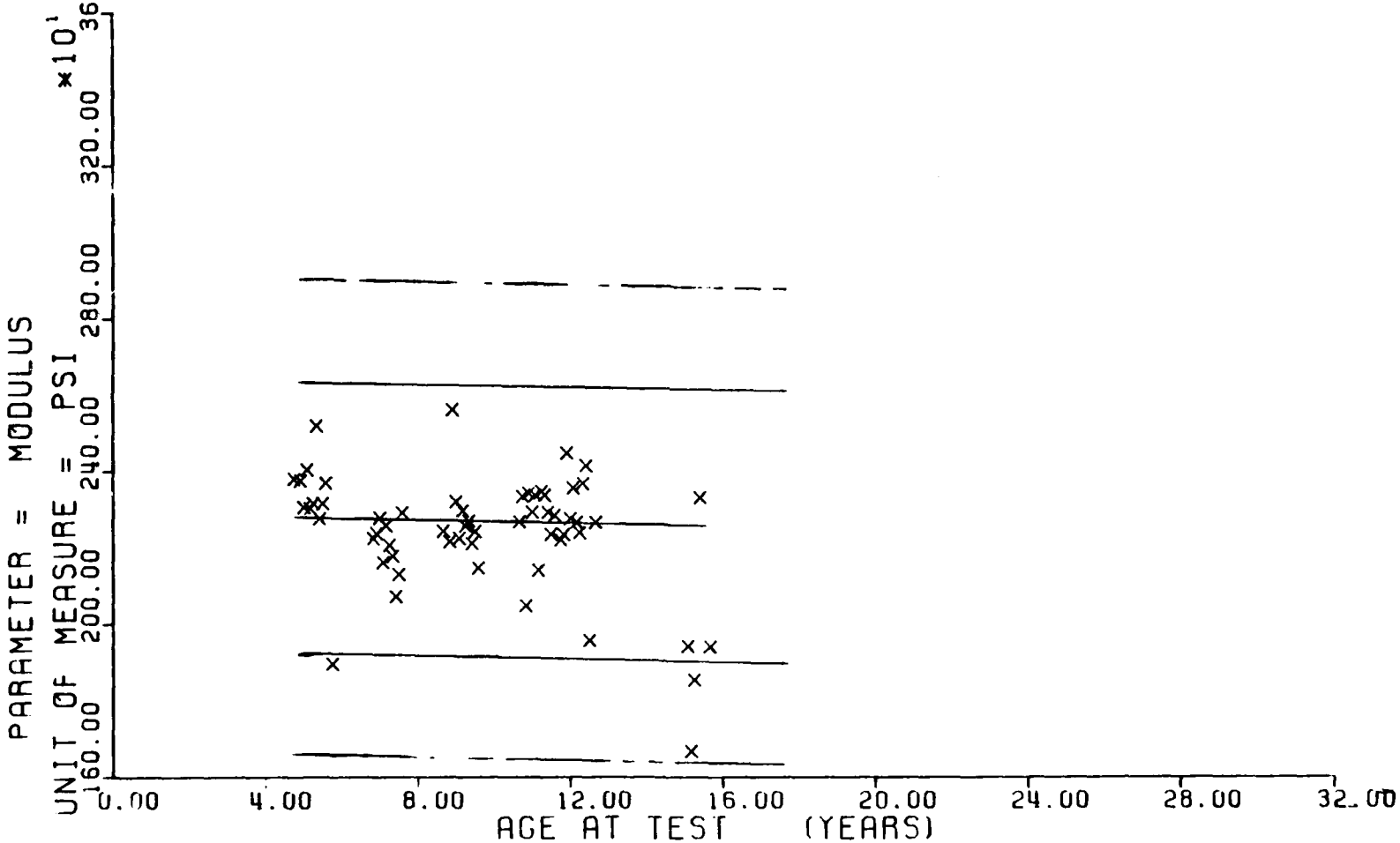
F = +4.0031866E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σ_Y = +2.0716877E+02

R = -2.4027628E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S_B = +2.8143981E-01

ι = +6.3270741E-01 SIGNIFICANCE OF ι = NOT SIGNIFICANT S_E = +2.0725834E+02

N = 695 DEGREES OF FREEDOM = 693

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STEP 1, WING 6, IP-H1043, MODULUS, LOW RATE, CHS=2.0

Figure 10

TABLE 6

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVARIANCE.COMPARES REGRESSIONS.IF=3104 .DF=2.6.MODELOS. FIE.=276

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN MODELS	1756	0.29147E+07	-0.10617E+06	0.57934E+09	-0.7112	1752	0.99921E+09	0.56607E+06
MODELS	694	0.54232E+06	-96576.	0.29786E+08	-0.17807	693	0.29786E+08	42956.
						2445	0.56897E+09	0.59630E+06
POOLED	2447	0.34570E+07	-0.10914E+06	0.10151E+10	-.1569	2446	0.57487E+09	0.39846E+06
DIFFERENCE BETWEEN SLOPES						1	0.57071E+07	0.57071E+07
BETWEEN	1	77744.	0.46976E+06	0.28545E+07				
TOTAL	2446	0.35344E+07	-0.10444E+06	0.10320E+10		2447	0.96121E+09	
BETWEEN ADJUSTED LINES						1	0.64476E+07	0.64476E+07

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 14.48(DF=1756, 693) — STATISTICALLY DIFF.
IF NO DEGREE OF RESIDUAL VARIANCES IS TREE CONTROL WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION THREE LINE SLOPES : F= 14.08(DF= 1,2445) — STATISTICALLY DIFF.
COMPARISON OF REGRESSION THREE LINE ELEVATIONS : F= 16.12(DF= 1,2446) — STATISTICALLY DIFF.

*** SAMPLE SIZE SUMMARY ***

AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP
57	2	94	27	121	21	147	8	174	11	200	9
59	3	95	15	122	3	148	11	175	9	201	6
60	6	96	24	123	12	149	6	176	3	202	18
61	9	98	9	124	9	150	7	177	6	203	12
62	6	99	21	126	4	151	6	178	6	204	15
63	9	100	3	127	5	152	3	179	9	205	15
64	3	101	12	128	9	153	12	180	12		
65	9	102	12	129	6	155	6	181	12		
66	6	103	3	130	6	156	6	183	12		
67	3	105	2	131	3	157	9	184	18		
68	6	106	3	132	12	158	9	185	13		
79	6	107	9	133	3	159	12	186	15		
80	6	108	15	134	6	160	9	187	14		
81	9	109	9	135	15	161	9	188	15		
82	6	110	9	136	6	162	12	189	12		
84	6	111	6	137	9	163	9	190	24		
85	9	112	12	138	9	164	6	191	24		
86	12	113	9	139	9	165	10	192	29		
87	9	114	12	140	12	166	9	193	24		
88	9	115	6	141	6	167	12	194	9		
89	9	116	12	142	12	168	18	195	21		
90	15	117	9	143	21	169	9	196	15		
91	28	118	23	144	12	170	15	197	12		
92	33	119	3	145	12	171	18	198	6		
93	15	120	15	146	15	173	21	199	6		

STAGE 1, WING 2, TP-H1043, STRAIN AT MAX STRESS, HIGH RATE, CPS=1750.0

This sample size summary is applicable to figures 11, 13, 15, 17, and 19

*** SAMPLE SIZE SUMMARY ***

AGE (DAYS)	NO SAMP	AGE (DAYS)	NO SAMP
82	3	132	22
83	15	133	26
84	24	134	17
85	24	135	15
86	18	136	25
87	21	137	21
88	19	138	18
89	20	139	6
90	19	140	3
91	9	141	6
105	3	142	15
107	3	143	27
108	9	144	27
109	23	145	21
110	20	146	24
111	21	147	18
112	21	148	15
113	21	149	15
114	16	150	12
115	22		
116	12		
127	3		
129	3		
130	9		
131	21		

STAGE 1, WING 6, TP-H1043, STRAIN AT MAX STRESS, HIGH RATE, CHS=1750.0

This sample size summary is applicable to figures 12, 14, 16, 18 and 20

Y = ((+1.8865357E-01) + (-9.8356166E-05) * X)

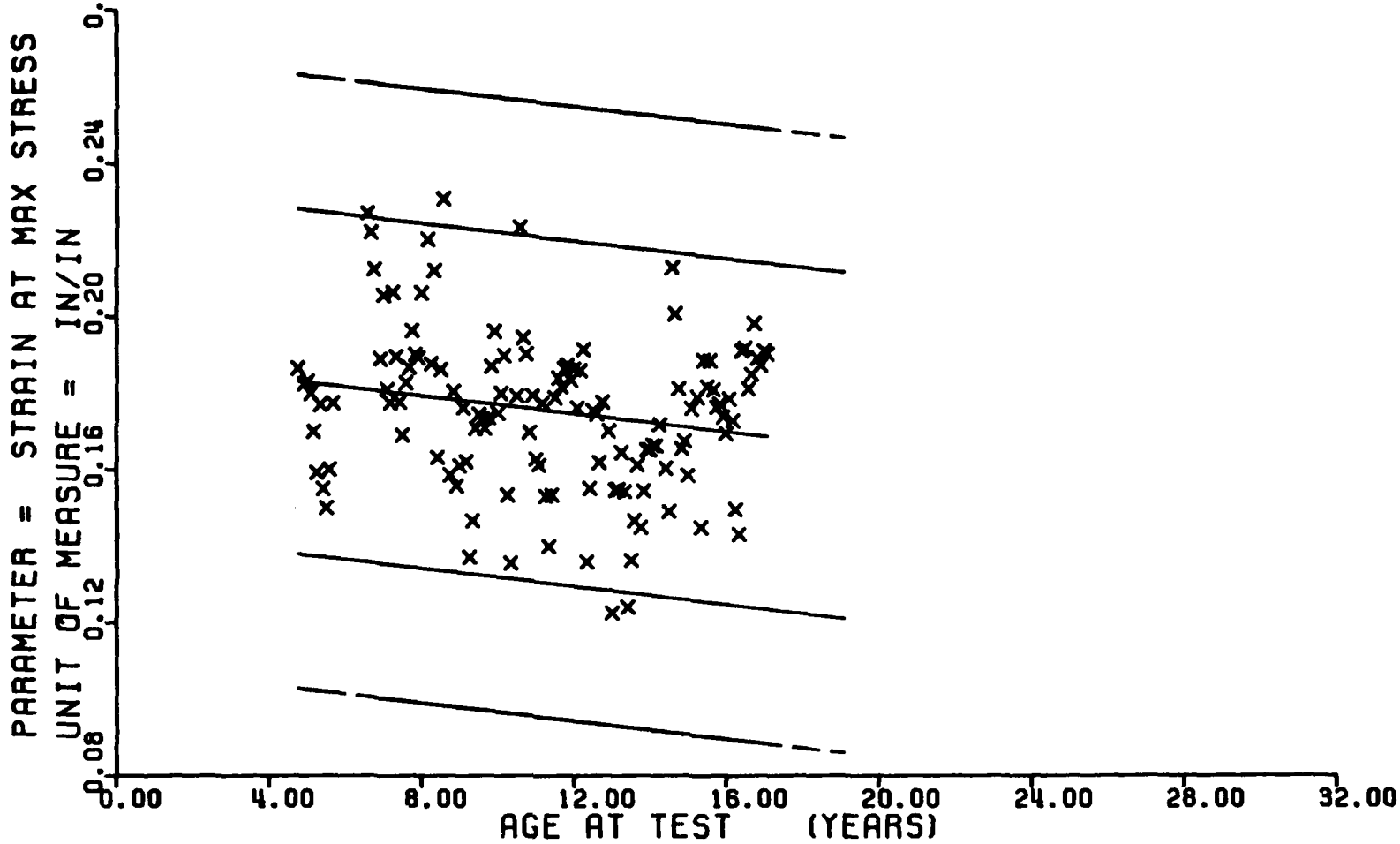
F = +3.2822844E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +2.7043860E-02

R = -1.5004990E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +1.7167754E-05

t = +5.7291225E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +2.6747061E-02

N = 1427 DEGREES OF FREEDOM = 1425

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, STRAIN AT MAX STRESS, HIGH RATE, CHS=1750.0

Figure 11

Y = ((+1.5541790E-01) + (+8.7935927E-05) * X)

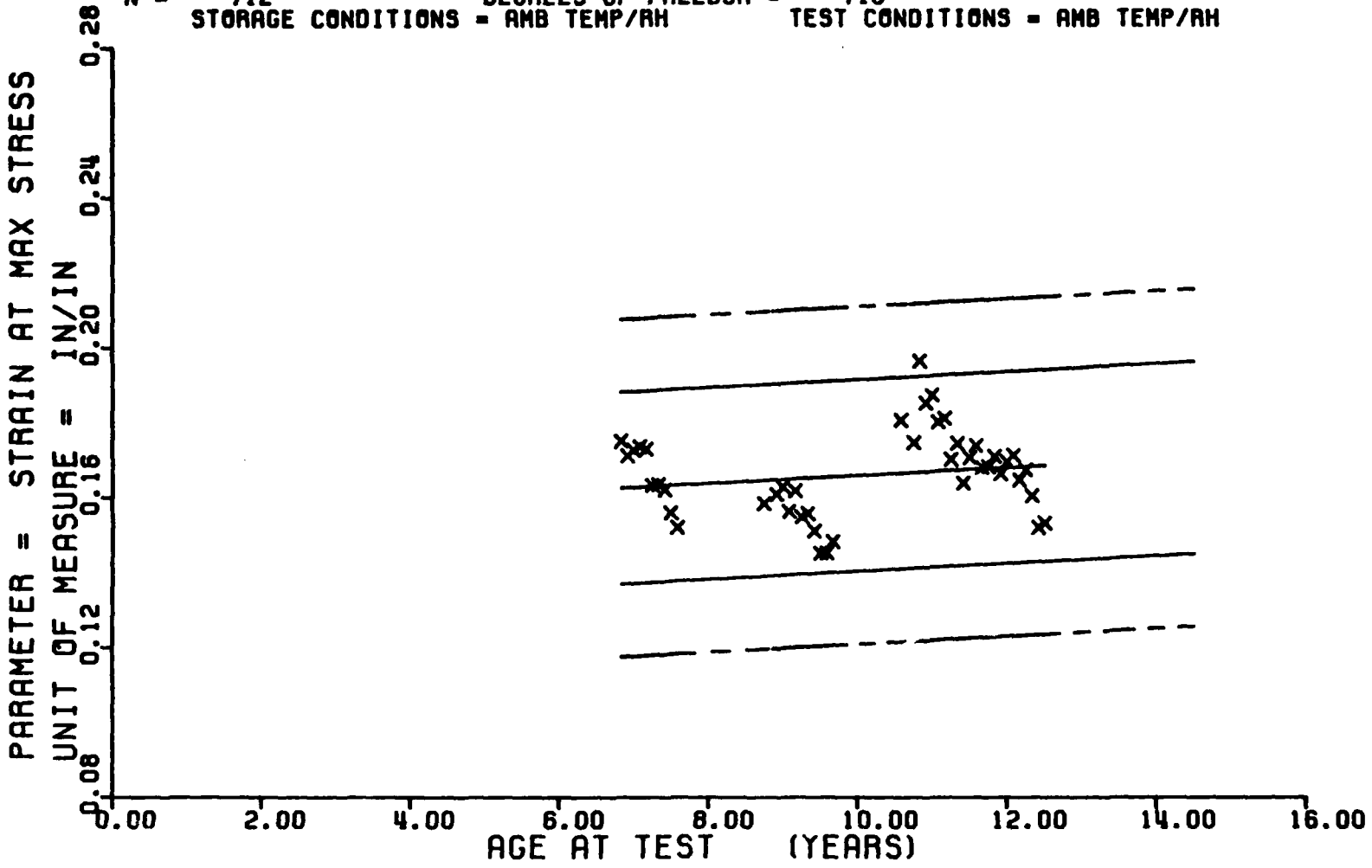
F = +1.2422164E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +1.5135254E-02

R = +1.3113031E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +2.4949837E-05

t = +3.5245090E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +1.5015126E-02

N = 712 DEGREES OF FREEDOM = 710

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, STRAIN AT MAX STRESS, HIGH RATE, CHS=1750.0

Figure 12

TABLE 7

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVAR.(COMPARES REGRESSIONS),TP=81743,CS=17[illegible],STEP MAX SIGS.=2/-

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN								
SMS2HR	1426	0.29273[illegible]+07	-256.74	1.0[illegible]	-0.[illegible]556[illegible]-04	1425	1.0195	0.71541E-03
SMS6HR	711	0.5[illegible]+06	31.149	0.1[illegible]	0.7[illegible]E-04	710	0.15006	0.21141E-03
						2135	1.1795	0.55247E-03
POOLED	2137	0.27695E+07	-215.69	1.2[illegible]	-0.7[illegible]E-04	2136	1.1905	0.55754E-03
DIFFERENCE OF TWO SLOPES						1	0.10937E-01	0.10937E-01
ERROR	1	0.2111[illegible]+06	67.[illegible]91	0.[illegible]21E-01				
TOTAL	2138	0.2[illegible]+07	-114.30	1.2[illegible]		2137	1.2377	
ERROR ADJUSTED FOR						1	0.47246E-01	0.47246E-01

STEP 1:
COMPARISON OF ERROR RESIDUAL VARIANCES : F= 0.17[illegible] (1425, 7[illegible]) STATISTICALLY DIFF.
IF [illegible] RESIDUAL VARIANCES IS TRUE CONT. WITH STEP 2.

STEP 2:
COMPARISON OF [illegible] : F= 19.[illegible] (1,2135) STATISTICALLY DIFF.
COMPARISON OF [illegible] : F= 0.7[illegible] (1,1[illegible]) STATISTICALLY DIFF.

Y = ((+4.9569479E+02) + (-1.2070152E-01) * X)

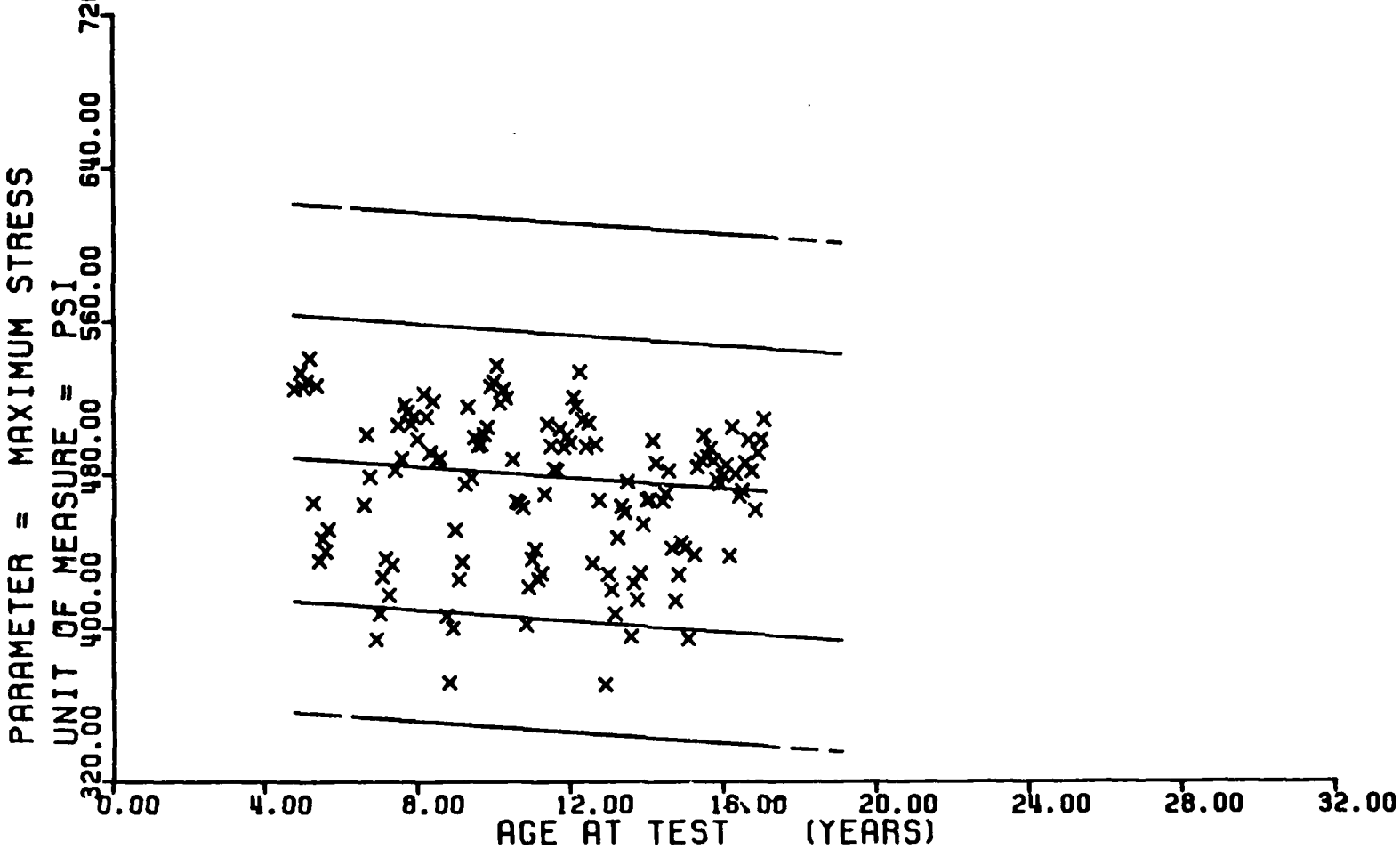
F = +1.8124830E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +4.4435547E+01

R = -1.1206888E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +2.8351481E-02

t = +4.2573267E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +4.4171114E+01

N = 1427 DEGREES OF FREEDOM = 1425

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, MAXIMUM STRESS, HIGH RATE, CHS=1750.0

Figure 13

Y = ((+4.3251480E+02) + (+4.2835280E-01) * X)

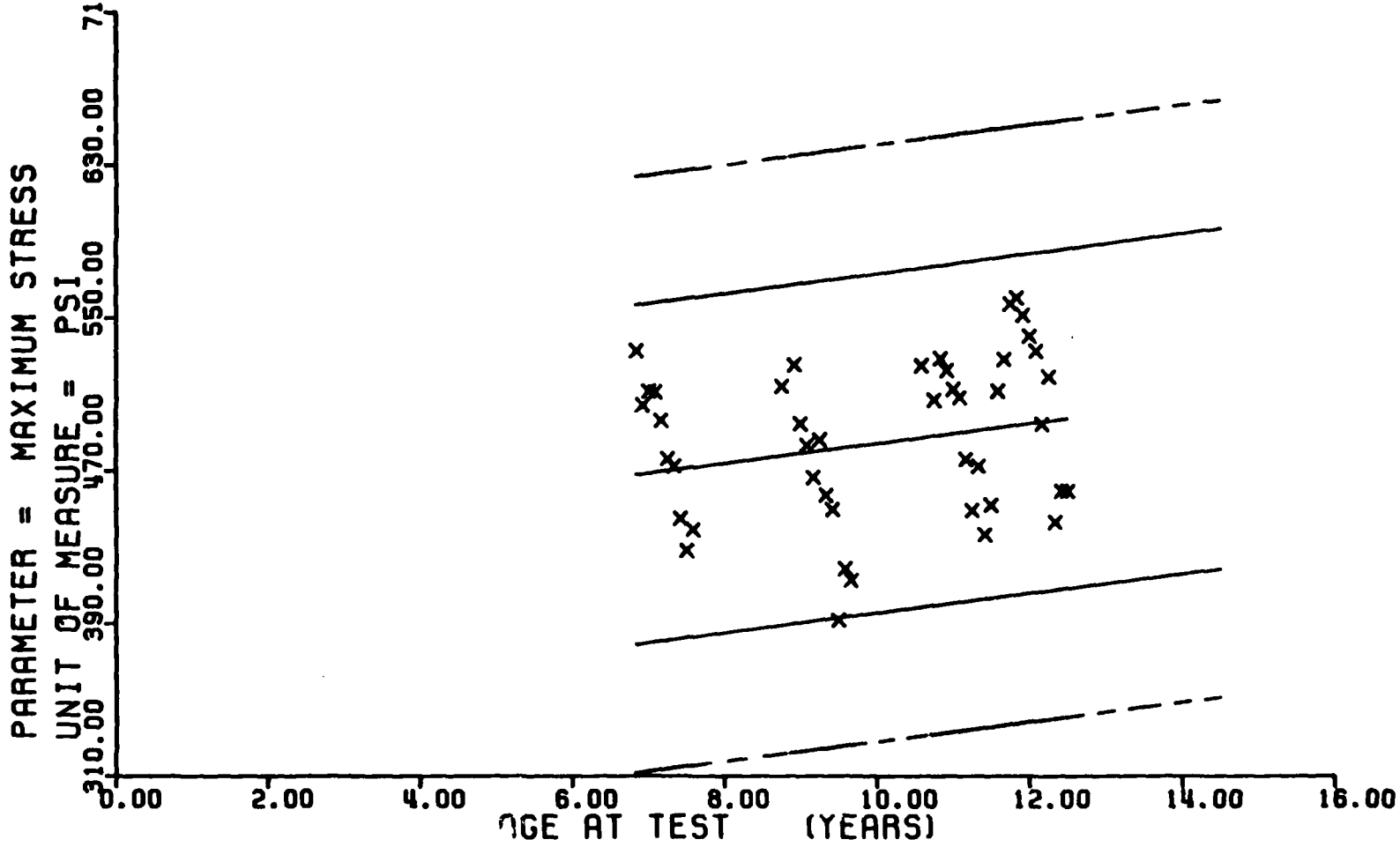
F = +2.4570792E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +5.2860994E+01

R = +1.8289117E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +8.6415576E-02

t = +4.9568934E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +5.2005982E+01

N = 712 DEGREES OF FREEDOM = 710

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, MAXIMUM STRESS, HIGH RATE, CHS=1750.0

Figure 14

TABLE 8

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVAR.(COMPARES REGRESSIONS).IF=0.045,CF=1750.MAX STRESS,W100=270

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	DEVIATIONS FROM REGRESSION D.F.	SUM SQ.	MEAN SQ.
WITHIN								
MXS2HR	1426	0.24273E+07	-0.29296E+06	0.6157E+07	-0.12070	1425	0.27803E+07	1951.1
MXS6HR	711	0.36210E+06	0.15514E+06	0.1906E+07	0.42835	710	0.19203E+07	2704.6
						2135	0.47006E+07	2201.7
POOLED	2137	0.27986E+07	-0.13704E+06	0.48124E+07	-0.49414E-01	2136	0.47956E+07	2244.1
DIFFERENCE BETWEEN SLOPES						1	95006.	95006.
BETWEEN	1	0.21110E+06	-5554.	13969.				
TOTAL	2138	0.50096E+07	-0.19134E+06	0.49162E+07		2137	0.48040E+07	
BETWEEN ADJUSTED ENDS						1	8454.0	8454.0

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 1.39(DF= 710,1425) — STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION TREND LINE SLOPES : F= 42.15(DF= 1,2135) — STATISTICALLY DIFF.
COMPARISON OF REGRESSION TREND LINE ELEVATIONS : F= 3.76(DF= 1,2136) — NOT STATISTICALLY DIFF.

Y = ((+3.0778857E-01) + (-1.4608721E-04) * X)

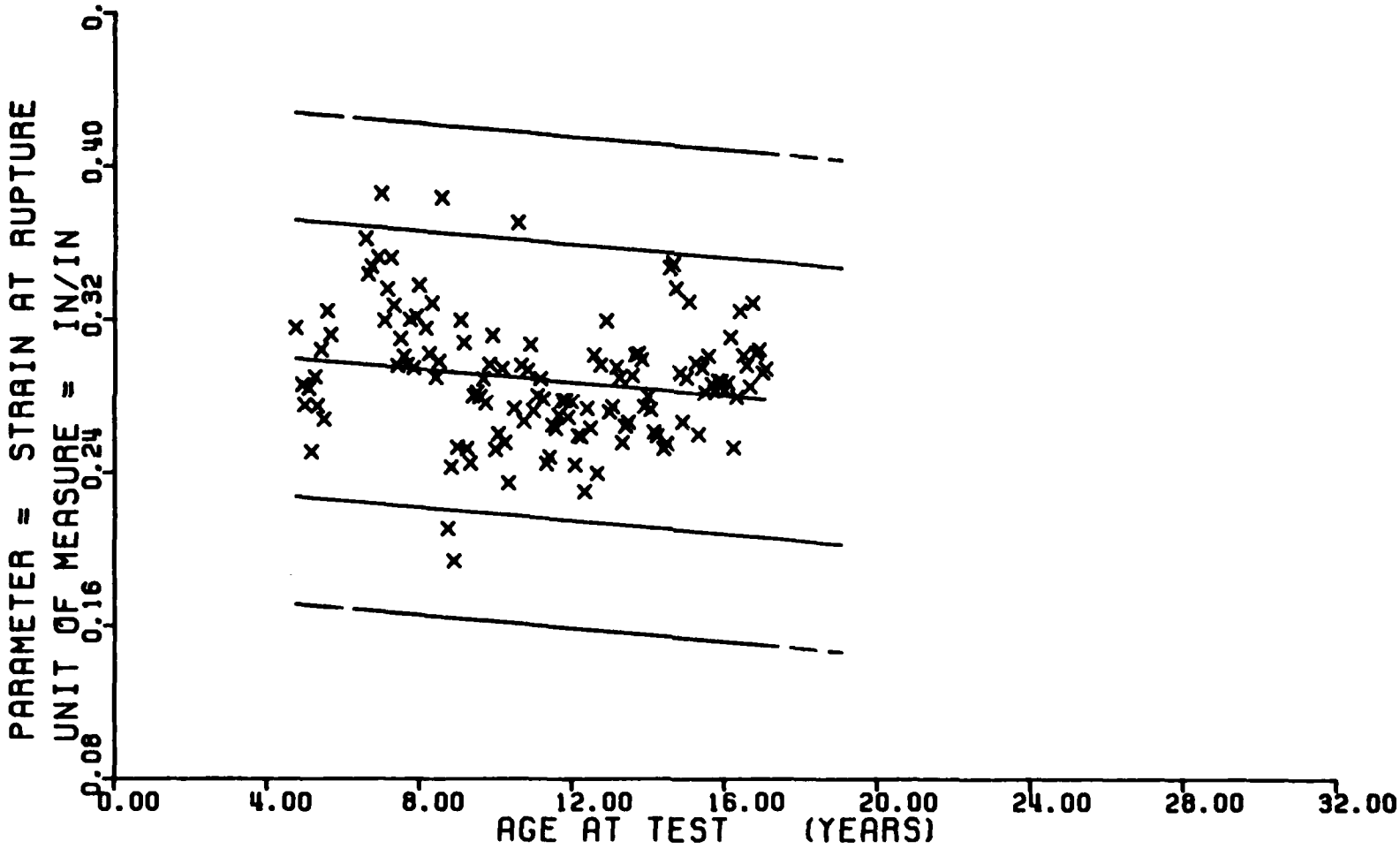
F = +2.8331608E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +4.3167986E-02

R = -1.3962180E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +2.7445844E-05

t = +5.3227444E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +4.2760147E-02

N = 1427 DEGREES OF FREEDOM = 1425

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, STRAIN AT RUPTURE, HIGH RATE, CHS=1750.0

Figure 15

Y = ((+2.2861467E-01) + (+3.6023994E-04) * X)

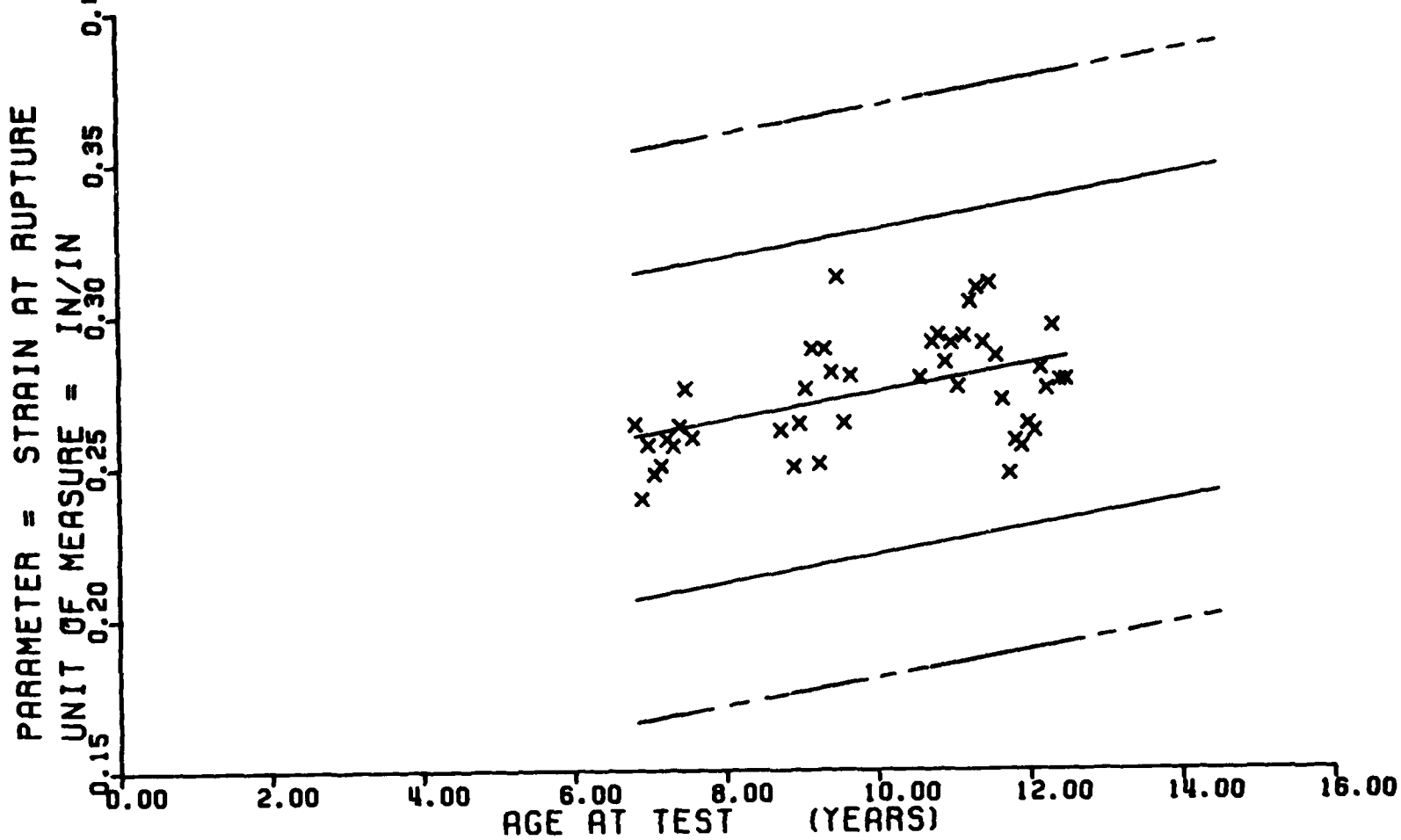
F = +5.3389088E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +3.2451213E-02

R = +2.6445591E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +5.2039305E-05

t = +7.3067837E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +3.1317909E-02

N = 712 DEGREES OF FREEDOM = 710

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, STRAIN AT RUPTURE, HIGH RATE, CHS=1750.0

Figure 16

TABLE 9

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVAR.(COMPARES REGRESSIONS),TP=.1043,C=.1750,STEP FORWARD,W=.76

SOURCE	D.F.	CORRECTED SUM OF SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN								
SUB2HR	1426	0.24273E+07	-354.60	2.6775	-0.14609E-03	1425	2.5655	0.18784E-02
SUB6HR	711	0.3[illegible]21E+06	157.72	0.74775	0.2[illegible]624E-03	710	0.6[illegible]658	0.9[illegible]062E-03
						2135	3.3013	0.15466E-02
POOLED	2137	0.27895E+07	-216.56	3.4[illegible]1	-0.77759E-04	2136	3.3892	0.15867E-02
DIFFERENCE BETWEEN SLOPES						1	0.87305E-01	0.87305E-01
BETWEEN	1	0.2111[illegible]E+06	120.60	0.79191E-01				
TOTAL	2138	0.3[illegible]00E+07	-96.26	3.4[illegible]45		2137	3.4560	
DEVIATE ADJUSTED EMES						1	0.92759E-01	0.92759E-01

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= [illegible] (DF=1425, 710) — STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTROL WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION BETW LINE SLOPES : F= 58.45(DF= 1,2135) — STATISTICALLY DIFF.
COMPARISON OF REGRESSION BETW LINE DEVIATIONS : F= 58.9[illegible](DF= 1,2135) — STATISTICALLY DIFF.

Y = ((+4.0950906E+02) + (-3.2728309E-02) * X)

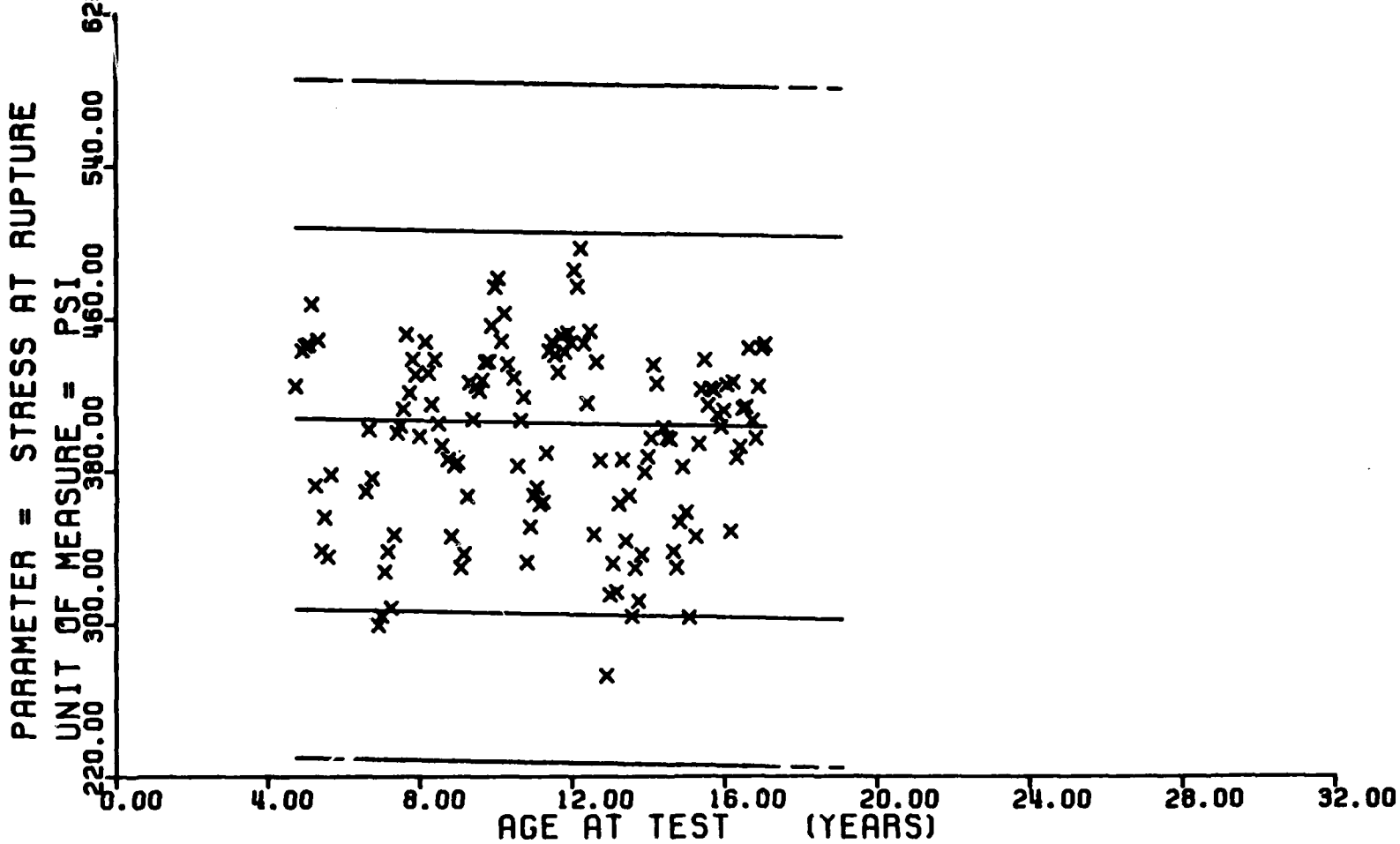
F = +7.4105963E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σ_Y = +5.9227057E+01

R = -2.2798498E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S_B = +3.8018676E-02

t = +8.6084820E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT S_E = +5.9232435E+01

N = 1427 DEGREES OF FREEDOM = 1425

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, STRESS AT RUPTURE, HIGH RATE, CHS=1750.0

Figure 17

Y = ((+3.7477006E+02) + (+3.5808746E-01) * X)

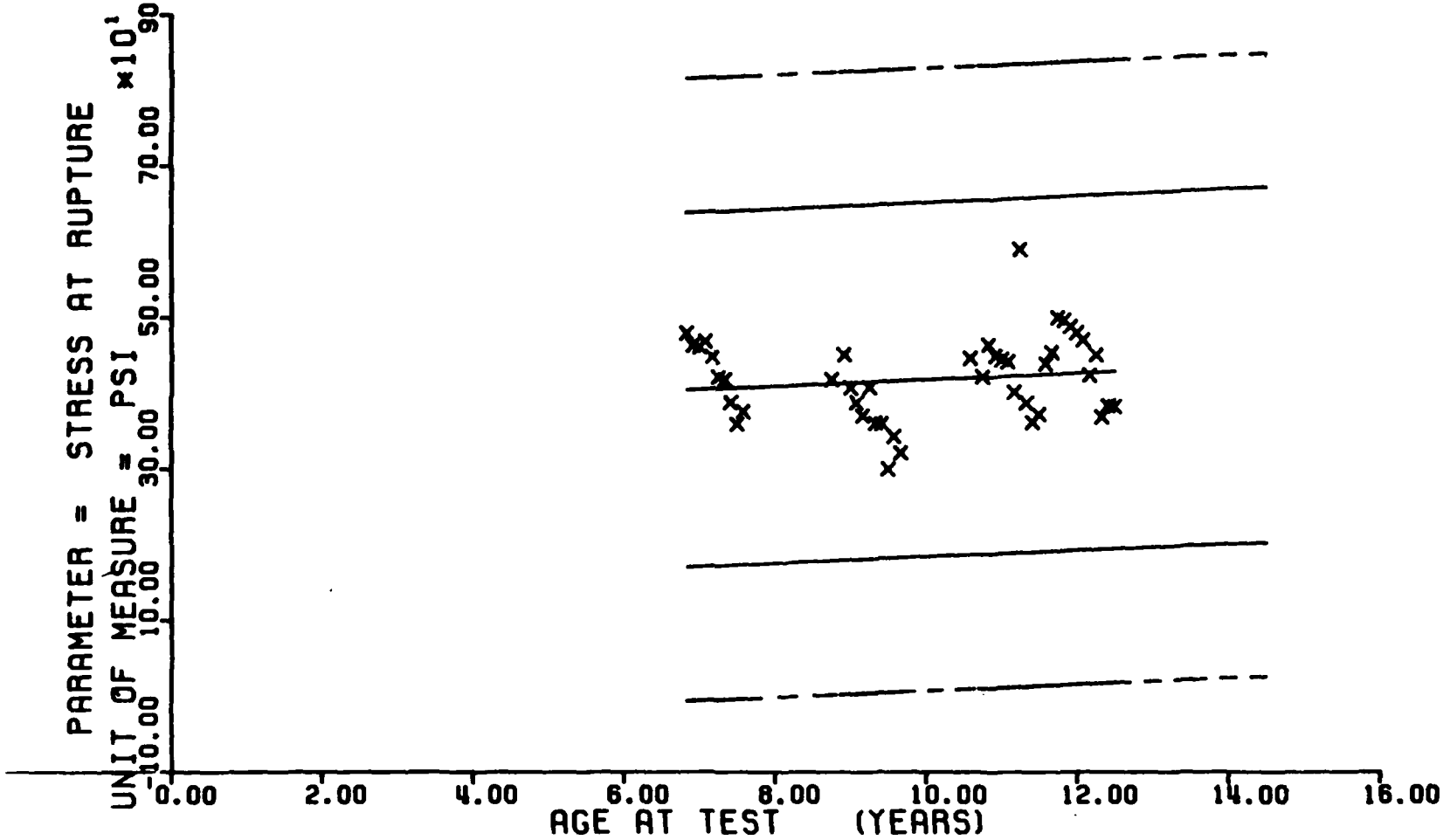
F = +2.4739415E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ_Y = +1.3715301E+02

R = +5.8926442E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S_B = +2.2766402E-01

t = +1.5728768E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT S_t = +1.3701107E+02

N = 712 DEGREES OF FREEDOM = 710

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, STRESS AT RUPTURE, HIGH RATE, CHS=1750.0

Figure 18

TABLE 10

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVAR.(COMPARES REGRESSIONS),TP=H1043,CRS=1750,STRS RUPTURE,W=276

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN								
SRP2PP	1426	0.24273E+07	-79441.	0.50122E+07	-0.32728E-01	1425	0.4999EE+07	3501.5
SRP6PP	711	0.3F213E+06	0.12969E+06	0.13375E+06	0.35609	710	0.1552[illegible]E+08	18772.
						2135	0.1[illegible]20E+08	8566.4
POOLED	2137	0.27895E+07	50251.	0.18477E+06	0.18015E-01	2136	0.1[illegible]7[illegible]E+08	8602.9
BETWEEN				DIFFERENCE BETWEEN SLOPES		1	48136.	48136.
BETWEEN	1	0.21112E+06	-0.12931E+06	79172.				
TOTAL	2138	0.30006E+07	-79060.	0.18456E+06		2137	0.18454E+08	
				BETWEEN ADJUSTED MEANS		1	78512.	78512.

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 5.85(DF= 710,1425) STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION TREND LINE SLOPES : F= 5.61(DF= 1,2135) STATISTICALLY DIFF.
COMPARISON OF REGRESSION TREND LINE ELEVATIONS : F= 9.16(DF= 1,2136) STATISTICALLY DIFF.

Y = ((+5.9570324E+03) + (+3.7694605E+00) * X)

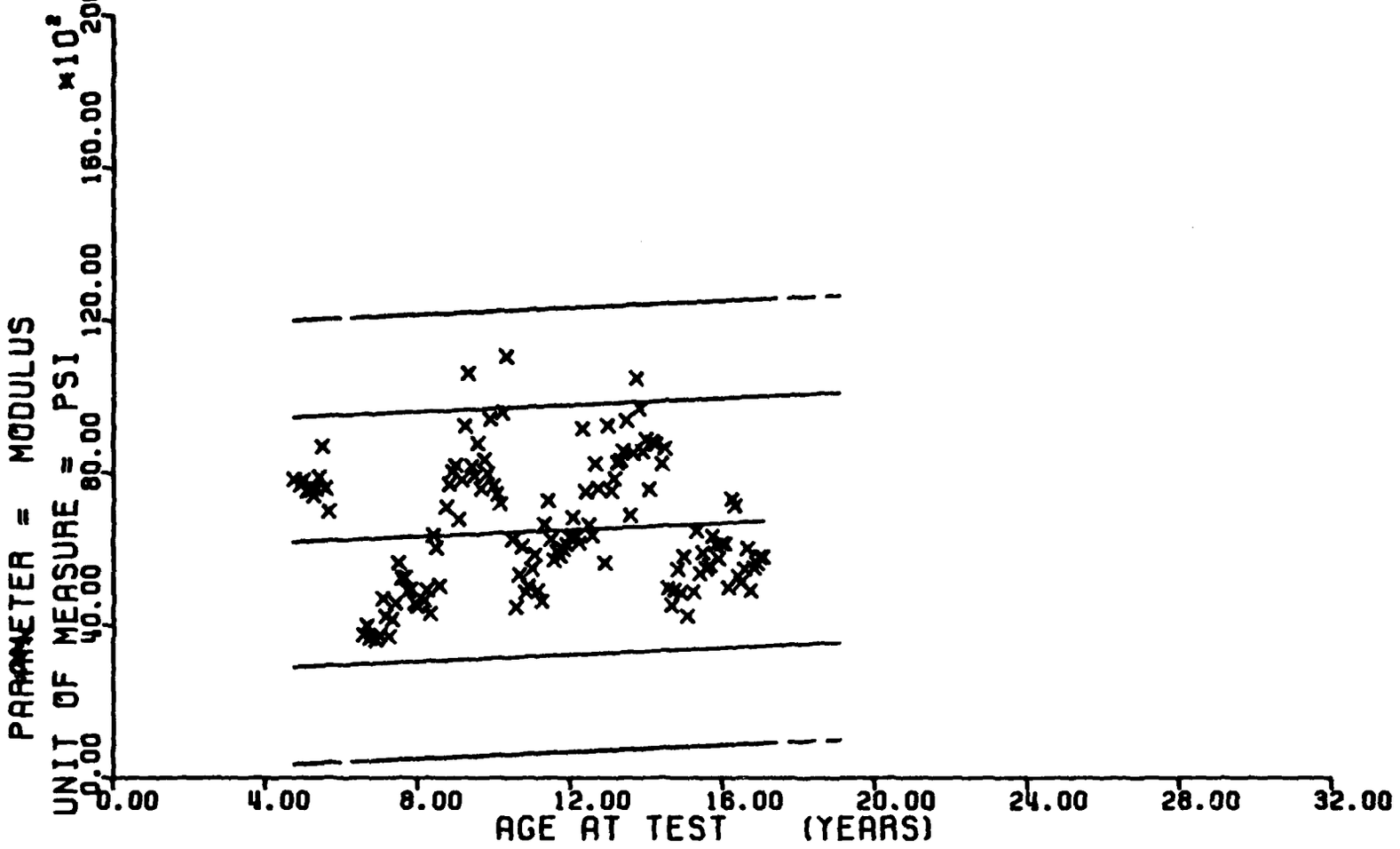
F = +9.1353145E+00 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +1.9485669E+03

R = +7.9811723E-02 SIGNIFICANCE OF R = SIGNIFICANT S_b = +1.2471464E+00

t = +3.0224682E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +1.9430323E+03

N = 1427 DEGREES OF FREEDOM = 1425

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, MODULUS, HIGH RATE, CHS=1750.0

Figure 19

Y = ((+1.0009277E+04) + (-2.1326746E+01) * X)

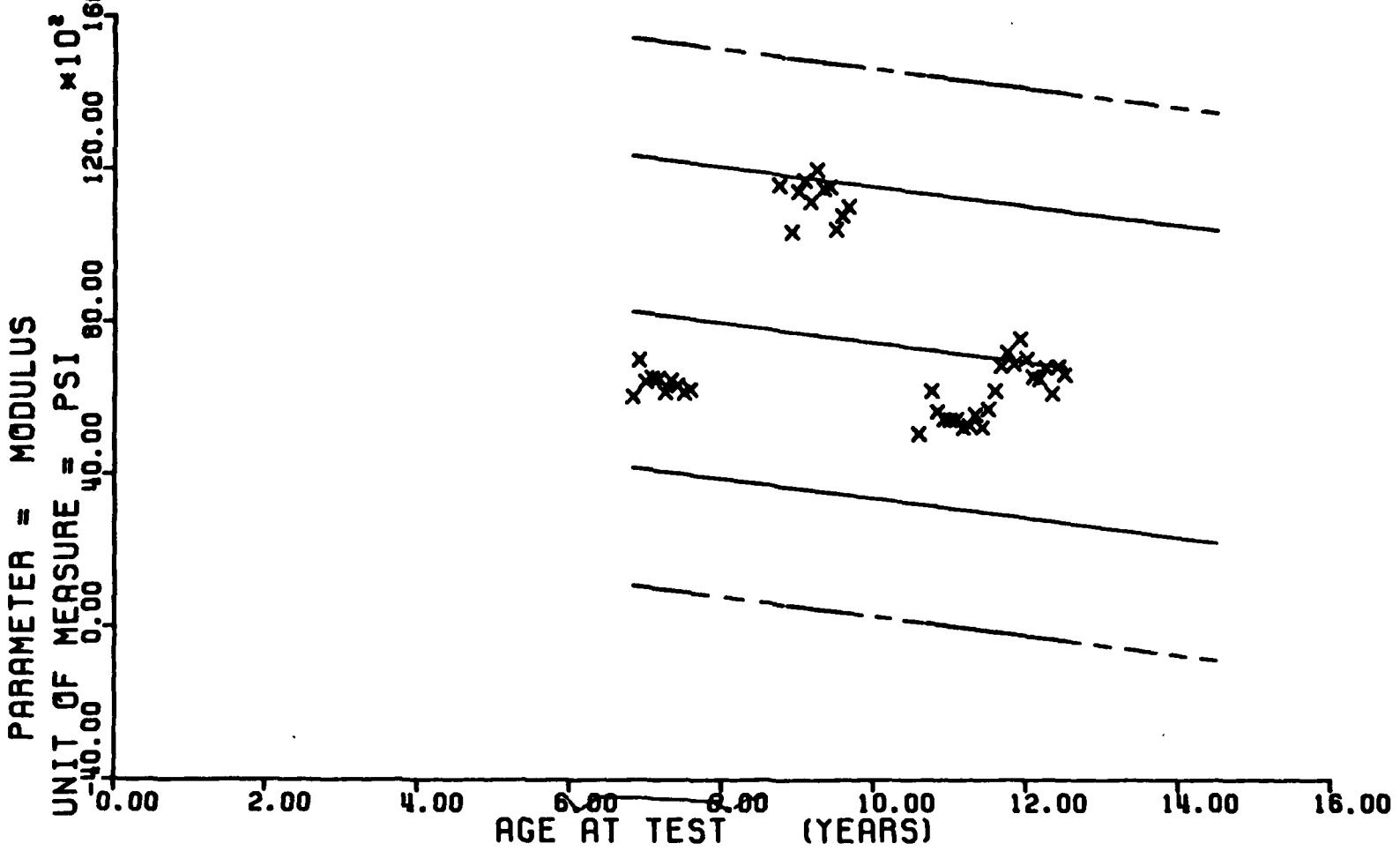
F = +2.8875646E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +2.4348426E+03

R = -1.9768794E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +3.9687957E+00

t = +5.3736064E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +2.3884712E+03

N = 712 DEGREES OF FREEDOM = 710

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, MODULUS, HIGH RATE, CHS=1750.0

Figure 20

20

TABLE 11

ANALYSIS OF COVARIANCE
(COMPARISON OF REGRESSION LINES)

ANALYSIS OF COVARIANCE(COMPARES REGRESSIONS),DF=01045,C.V.=17[illegible],MODELOS,WING=27[illegible]

SOURCE	D.F.	CORRECTED SUM OF SQUARES: SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION: SUM SQ.	MEAN SQ.
WITHIN								
*OPEN	1426	0.24273E+07	0.91496E+07	0.54144E+10	3.7694	1425	0.55799E+10	0.37754E+07
*OBERF	711	0.36218E+06	-0.77241E+07	0.42351E+10	-21.327	710	0.40504E+10	0.57048E+07
						2135	0.94305E+10	0.44170E+07
POOLED	2137	0.27895E+07	0.14255E+07	0.96[illegible]E+10	0.51103	2136	0.96[illegible]E+10	0.45079E+07
DIFFERENCE BETWEEN SLOPES						1	0.19049E+09	0.19049E+09
BETWEEN	1	0.21110E+06	-0.95816E+07	0.47496E+09				
TOTAL	2138	0.50006E+07	-0.15666E+07	0.10[illegible]4E+11		2137	0.10042E+11	
BETWEEN ADJUSTED MEANS						1	0.41552E+09	0.41352E+09

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 1.51(DF= 710,1425) — STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION TREND LINE SLOPES : F= 44.04(DF= 1,2135) — STATISTICALLY DIFF.
COMPARISON OF REGRESSION TREND LINE ELEVATIONS : F= 91.73(DF= 1,2136) — STATISTICALLY DIFF.

*** SAMPLE SIZE SUMMARY ***

AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP
56	5	92	9	120	20	148	15	185	20
58	5	93	6	121	40	149	9	186	20
59	10	94	11	123	20	150	5	187	10
60	5	95	6	124	13	151	5	190	10
61	15	96	3	126	6	152	5	191	10
62	10	98	1	127	3	153	5	192	10
63	10	99	1	128	12	155	5	193	50
64	10	101	10	130	6	156	10	194	10
65	10	102	11	131	15	158	25	195	35
66	10	103	15	132	19	159	5	196	25
67	11	105	10	133	25	160	5	197	10
68	5	106	5	134	14	161	15	198	10
78	2	107	15	135	17	163	5	199	5
80	4	108	20	136	11	164	5	200	15
81	1	109	15	137	21	165	10	201	5
82	2	110	15	138	3	166	25	202	15
83	1	111	10	139	9	167	10	203	10
84	1	112	20	140	15	168	15	204	20
85	5	113	15	141	9	169	5	205	15
86	4	114	20	142	18	170	10		
87	3	115	10	143	12	171	15		
88	1	116	20	144	8	173	15		
89	7	117	15	145	16	174	5		
90	5	118	40	146	18	181	10		
91	4	119	10	147	3	184	5		

STAGE 1, WING 2, TP-H1043, HARDNESS SHORE A, INITIAL

This sample size summary is applicable to figures 21 and 23

*** SAMPLE SIZE SUMMARY ***

AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP
82	12	146	35
83	15	147	40
84	24		
85	27		
86	15		
87	18		
88	21		
89	21		
90	9		
91	9		
106	5		
107	5		
108	10		
109	20		
110	25		
111	15		
112	15		
113	20		
114	15		
115	20		
141	15		
142	15		
143	30		
144	55		
145	25		

STAGE 1, WING 6, TP-H1043, HARDNESS SHORE A, INITIAL

This sample size summary is applicable to figures 22 and 24

Y = ((+8.3844469E+01) + (+4.2421133E-03) * X)

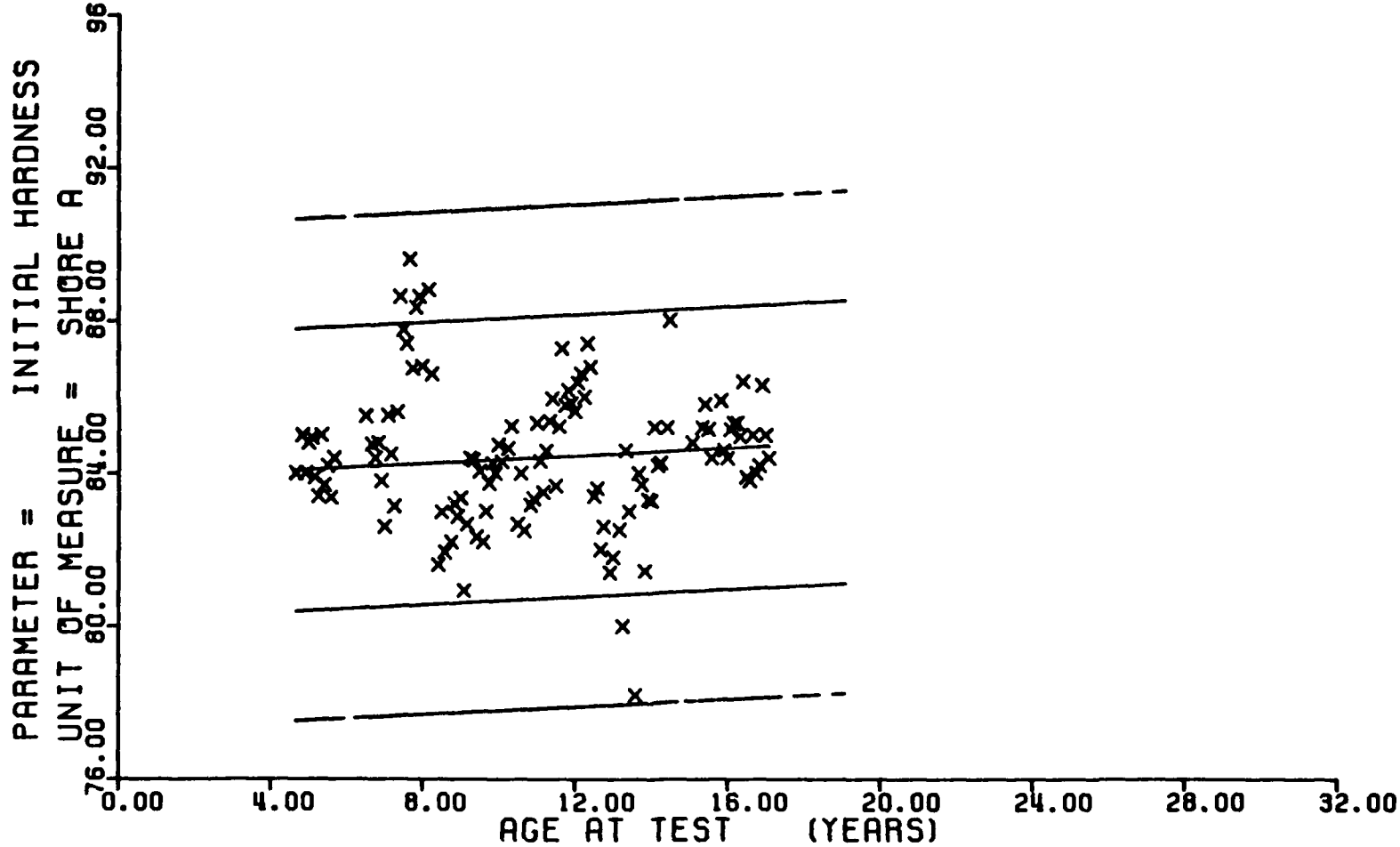
F = +8.2137571E+00 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +2.1961203E+00

R = +7.7509104E-02 SIGNIFICANCE OF R = SIGNIFICANT S_B = +1.4801691E-03

t = +2.8659653E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +2.1903190E+00

N = 1361 DEGREES OF FREEDOM = 1359

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, HARDNESS SHORE A, INITIAL

Figure 21

Y = ((+8.3294378E+01) + (+1.4302153E-02) * X)

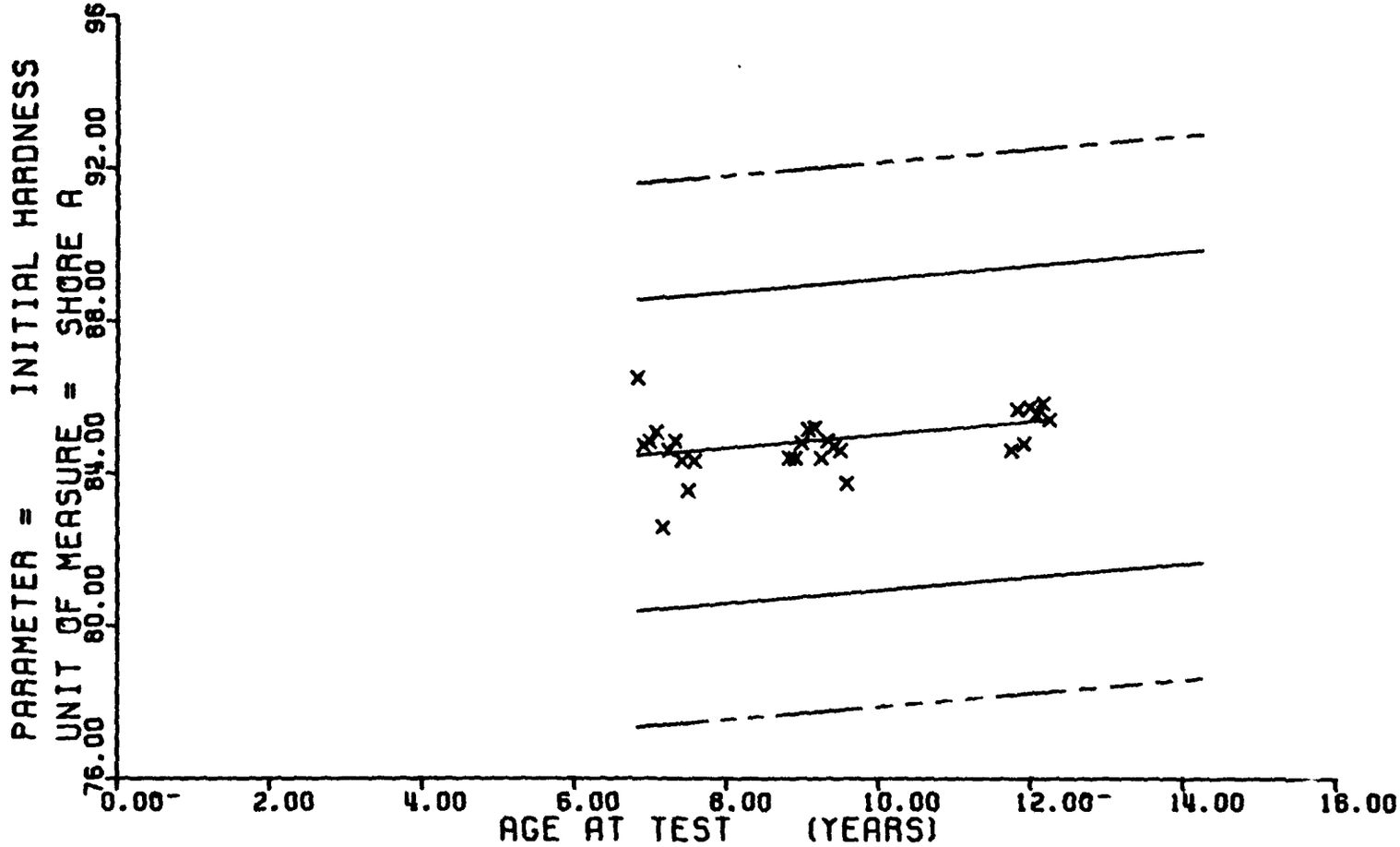
F = +1.2048420E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +2.4000471E+00

R = +1.4854207E-01 SIGNIFICANCE OF R = SIGNIFICANT S_b = +4.1203716E-03

t = +3.4710834E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +2.3756425E+00

N = 536 DEGREES OF FREEDOM = 534

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, HARDNESS SHORE A, INITIAL

Figure 22

TABLE 12

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVARIANCE,COMPARES REGRESSIONS,WING2/6,TP=H1043,HARDNESS SH=A,INITL

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN								
BASALT	1360	0.21897E+07	9290.0	6561.7	0.424251E-02	1359	6521.3	4.7986
BASALT	535	0.33249E+06	4754.4	3041.0	0.143622E-01	534	3013.0	5.6438
						1893	9535.1	5.0370
POOLED	1895	0.25222E+07	14044.	9602.5	0.556041E-02	1894	9564.3	5.0498
				DIFFERENCE BETWEEN SLOPES		1	29.207	29.207
BETWEEN	1	0.21130E+06	-4712.0	105.00				
TOTAL	1896	0.27335E+07	9332.4	9751.5		1895	9715.6	
				BETWEEN ADJUSTED MEANS		1	154.34	154.34

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 1.16(DF= 534,1359) STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION TREND LINE SLOPES : F= 5.10(DF= 1,1893) STATISTICALLY DIFF.
COMPARISON OF REGRESSION TREND LINE ELEVATIONS : F= 30.56(DF= 1,1894) STATISTICALLY DIFF.

Y = ((+7.4920583E+01) + (+2.1984429E-02) * X)

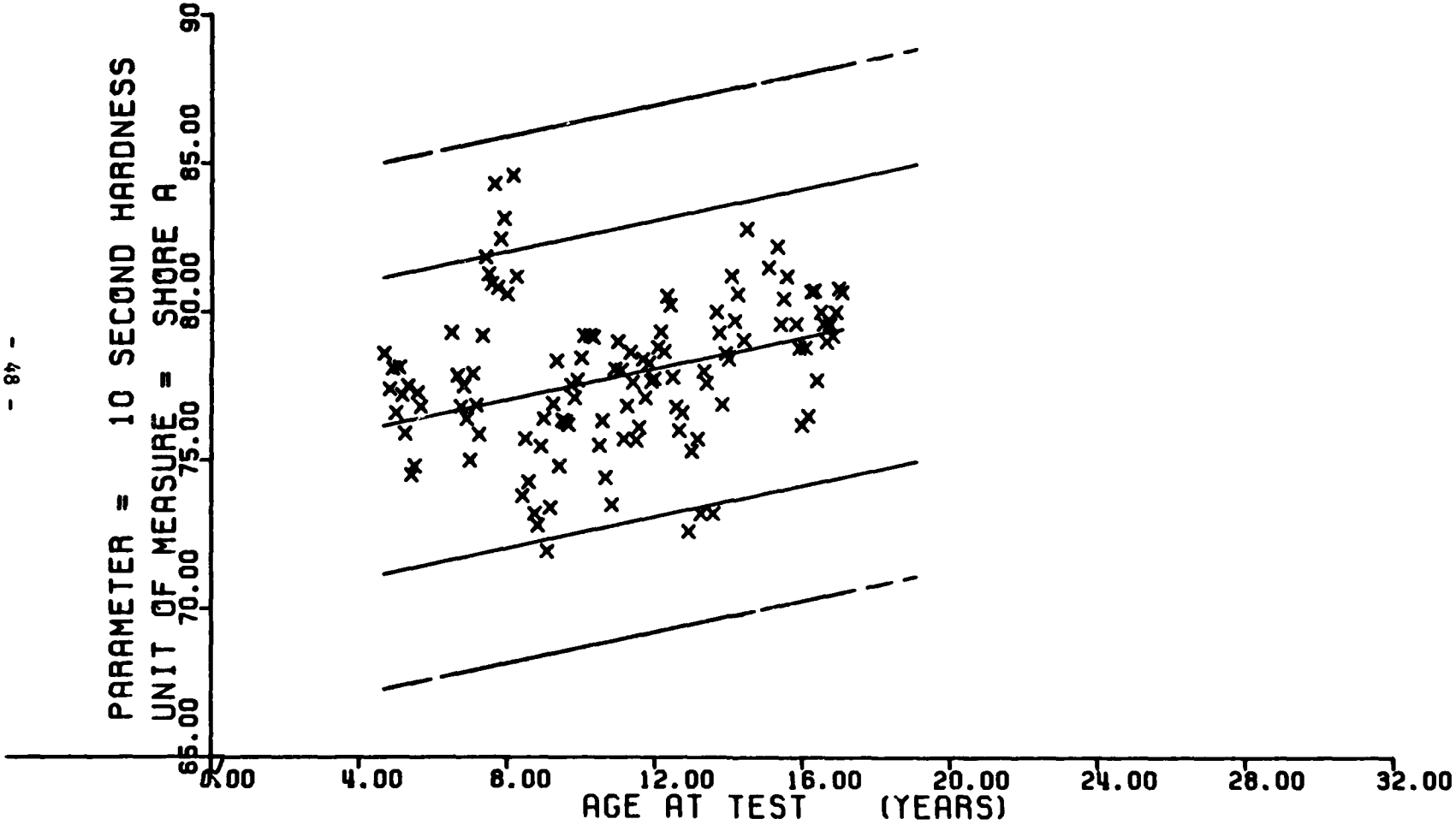
F = +1.2096331E+02 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +3.0856057E+00

R = +2.8589157E-01 SIGNIFICANCE OF R = SIGNIFICANT S_b = +1.9988875E-03

t = +1.0998332E+01 SIGNIFICANCE OF t = SIGNIFICANT S_e = +2.9579063E+00

N = 1361 DEGREES OF FREEDOM = 1359

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, HARDNESS SHORE A, 10-SECOND

Figure 23

Y = ((+8.1175598E+01) + (-2.8426624E-02) * X)

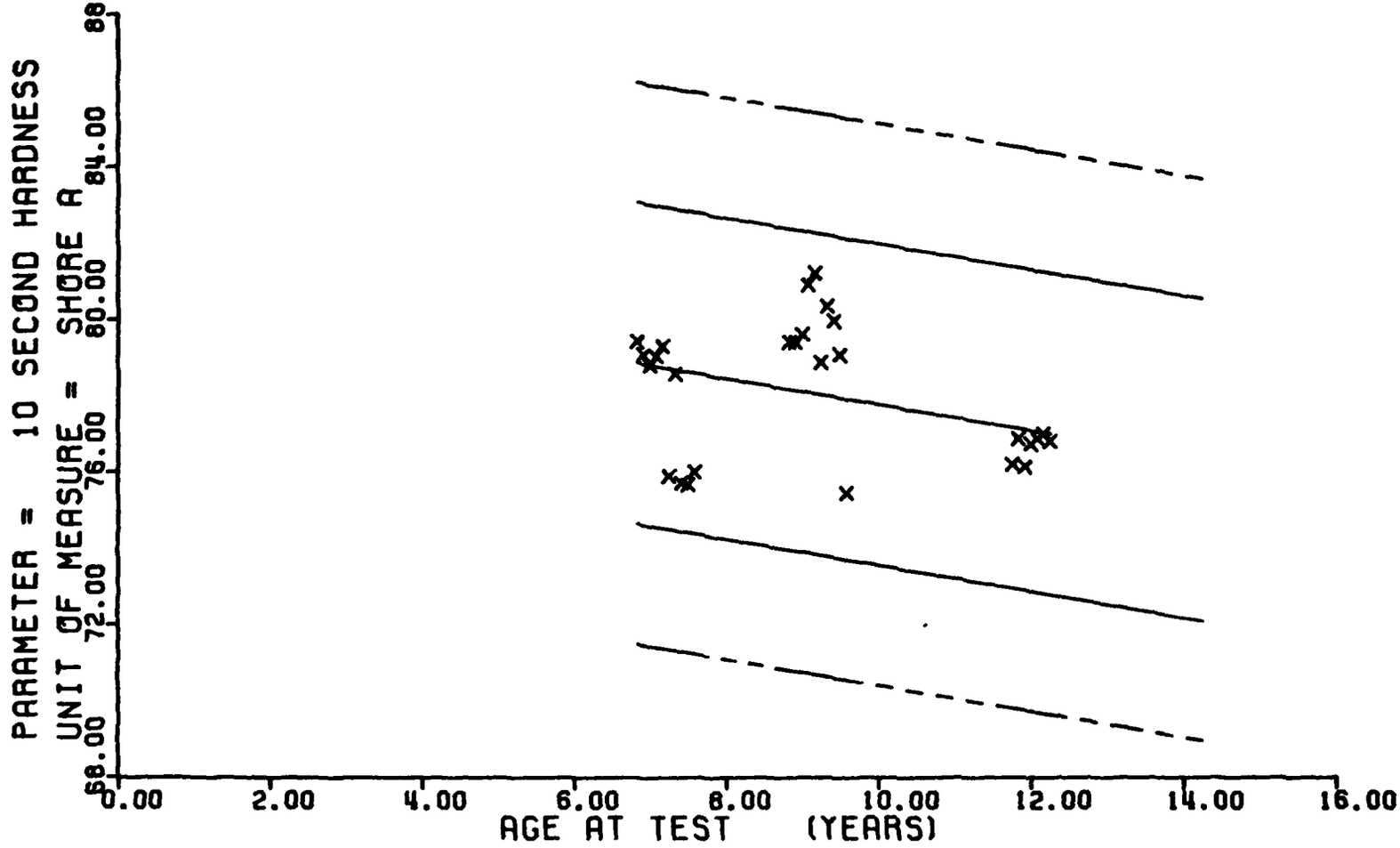
F = +4.4745643E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +2.5483647E+00

R = -2.7805551E-01 SIGNIFICANCE OF R = SIGNIFICANT S_b = +4.2496182E-03

t = +6.6892184E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +2.4501609E+00

N = 536 DEGREES OF FREEDOM = 534

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, HARDNESS SHORE A, 10-SECOND

Figure 24

TABLE 13

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVARIANCE,COMPARES REGRESSIONS,WING276,TP-H1043,HARDNESS SH-A,10SEC

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN								
H25A10	1360	0.21897E+07	46141.	12950.	0.21985E-01	1359	11692.	8.7503
H65A10	535	0.33242E+06	-9449.6	9474.5	-0.28427E-01	534	3205.5	6.0035
						1893	15096.	7.9754
POOLED	1895	0.25222E+07	36692.	16425.	0.15341E-01	1894	15831.	8.3585
DIFFERENCE BETWEEN SLOPES						1	735.45	735.45
BETWEEN	1	0.21130E+06	1256.0	20.000				
TOTAL	1896	0.27335E+07	39948.	16445.		1895	15861.	
BETWEEN ADJUSTED MEANS						1	29.746	29.746

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 1.46(DF=1359, 534) STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION TREND LINE SLOPES : F= 91.96(DF= 1,1893) STATISTICALLY DIFF.
COMPARISON OF REGRESSION TREND LINE ELEVATIONS : F= 3.50(DF= 1,1894) NOT STATISTICALLY DIFF.

*** SAMPLE SIZE SUMMARY ***

AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP
56	5	92	2	120	20	148	15	185	25
58	5	93	4	121	40	149	9	186	20
59	10	94	7	123	20	150	5	187	10
60	5	95	4	124	15	151	5	190	10
61	15	96	3	126	6	152	5	191	10
62	10	98	1	127	3	153	5	192	10
63	10	99	1	128	12	155	5	193	50
64	10	101	10	130	6	156	10	194	10
65	10	102	11	131	11	158	30	195	35
66	10	103	15	132	19	159	5	196	25
67	11	105	10	133	25	160	5	197	10
68	5	106	5	134	14	161	15	198	10
78	2	107	15	135	17	163	5	199	5
80	4	108	20	136	11	164	5	200	15
81	1	109	15	137	21	165	10	201	5
82	2	110	15	138	3	166	25	202	15
83	1	111	10	139	9	167	10	203	10
84	1	112	20	140	15	168	15	204	20
85	5	113	15	141	9	169	5	205	15
86	4	114	20	142	18	170	10		
87	3	115	10	143	12	171	15		
88	1	116	20	144	8	173	10		
89	4	117	15	145	16	174	5		
90	4	118	40	146	18	181	10		
91	2	119	10	147	3	184	5		

STAGE 1, WING 2, TP-H1043, HARDNESS SHORE C, INITIAL

This sample size summary is applicable to figures 25 and 27

*** SAMPLE SIZE SUMMARY ***

AGE (MOS)	NR SAMP	AGE (MOS)	NR SAMP
82	12	146	35
83	15	147	40
84	24		
85	27		
86	15		
87	18		
88	21		
89	21		
90	9		
91	9		
107	5		
108	10		
109	20		
110	25		
111	15		
112	15		
113	20		
114	15		
115	20		
140	5		
141	15		
142	15		
143	30		
144	50		
145	25		

STAGE 1, WING 6, TP-H:043, HARDNESS SHORE C, INITIAL

This sample size summary is applicable to figures 26 and 28

Y = ((+5.4760067E+01) + (-3.5216968E-02) * X)

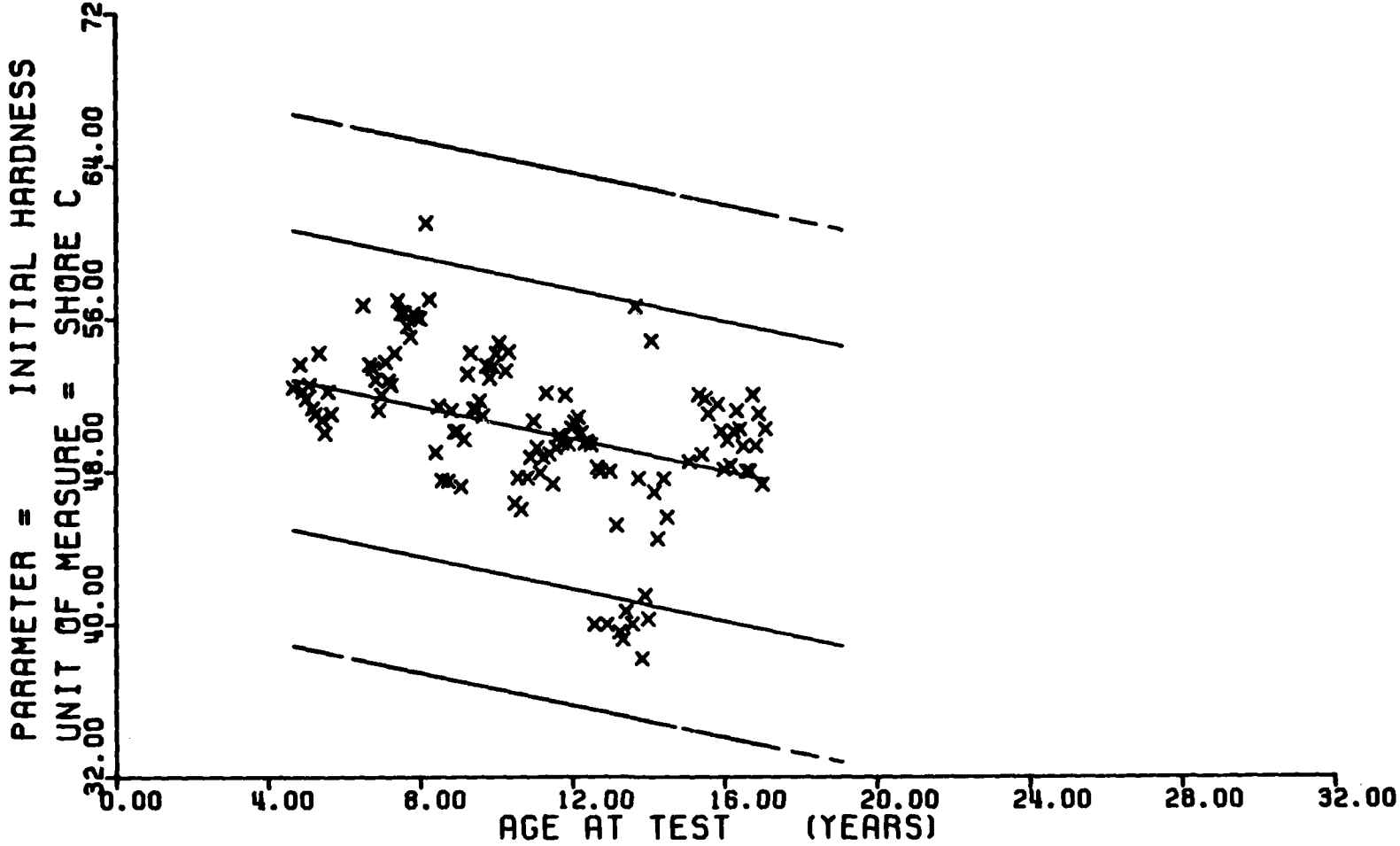
F = +1.2371085E+02 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +4.8468345E+00

R = -2.9082164E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +3.1662708E-03

t = +1.1122538E+01 SIGNIFICANCE OF t = SIGNIFICANT S_t = +4.6393645E+00

N = 1343 DEGREES OF FREEDOM = 1341

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2, TP-H1043, HARDNESS SHORE C, INITIAL

Figure 25

Y = ((+5.2305275E+01) + (-2.9923191E-02) * X)

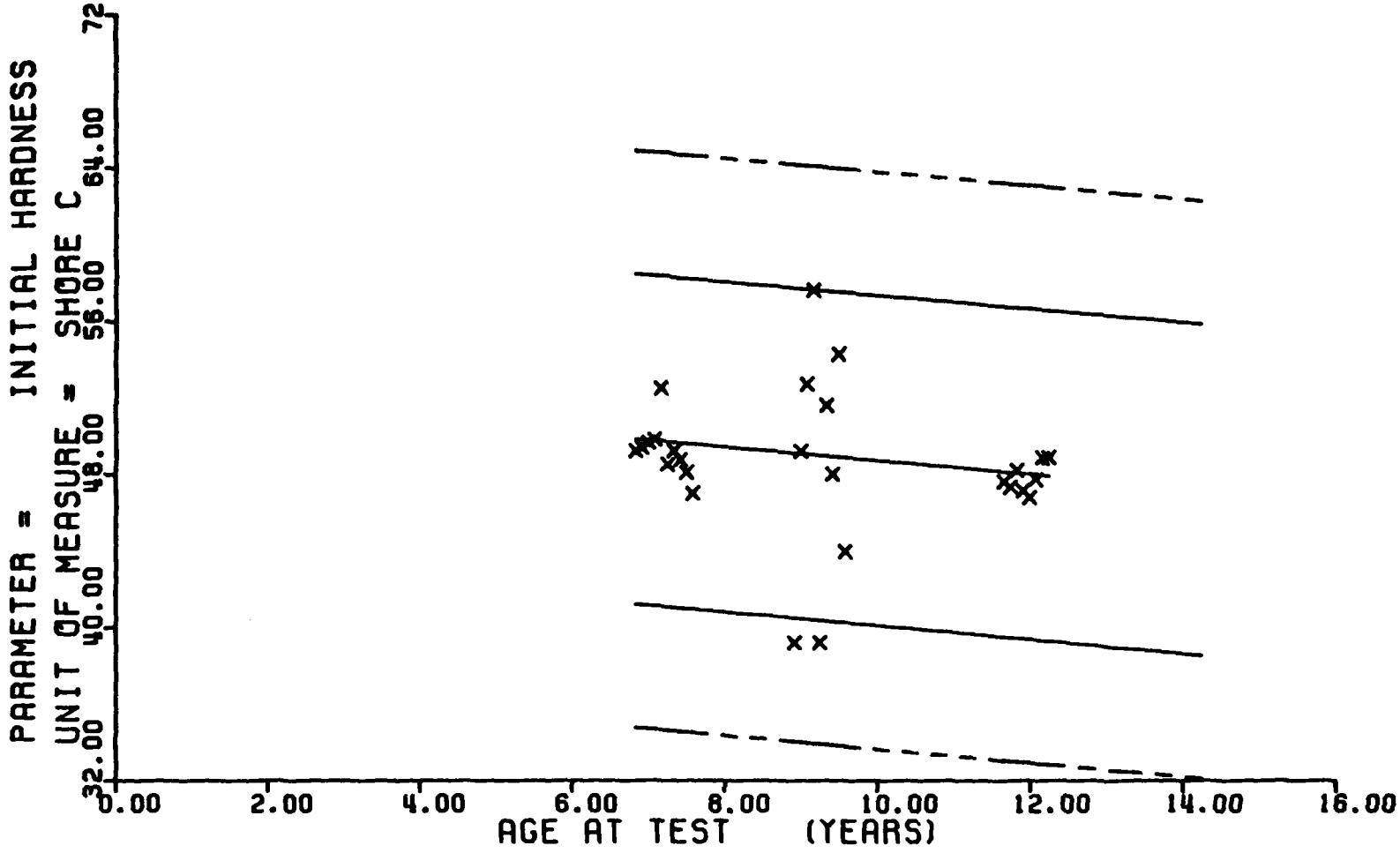
F = +1.1732180E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +5.0755321E+00

R = -1.4729848E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +8.7361188E-03

t = +3.4252271E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +5.0249114E+00

N = 531 DEGREES OF FREEDOM = 529

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, HARDNESS SHORE C, INITIAL

Figure 26

TABLE 14

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVARIANCE,COMPARES REGRESSIONS,WING2/6,TP-H1C43,HARDNESS SH-C,INITL

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	DEVIATIONS FROM REGRESSION D.F.	SUM SQ.	MEAN SQ.
WITHIN								
H2SCIN	1342	0.21469E+07	-75609.	31576.	-0.35217E-01	1341	28663.	21.524
H6SCIN	530	0.33064E+06	-9699.6	13653.	-0.29923E-01	529	13357.	25.250
						1870	42220.	22.578
POOLED	1872	0.24778E+07	-85509.	45179.	-0.34510E-01	1871	42226.	22.570
DIFFERENCE BETWEEN SLOPES						1	6.0156	6.0156
BETWEEN	1	0.23365E+06	9076.6	370.00				
TOTAL	1873	0.27014E+07	-76433.	45549.		1872	43387.	
BETWEEN ADJUSTED MEANS						1	1156.4	1156.4

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 1.1700(DF= 529,1341) STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION TREND LINE SLOPES : F= 0.36(DF= 1,1870) NOT STATISTICALLY DIFF.
COMPARISON OF REGRESSION TREND LINE ELEVATIONS : F= 51.32(DF= 1,1871) STATISTICALLY DIFF.

Y = ((+3.4481323E+01) + (-5.6467131E-03) * X)

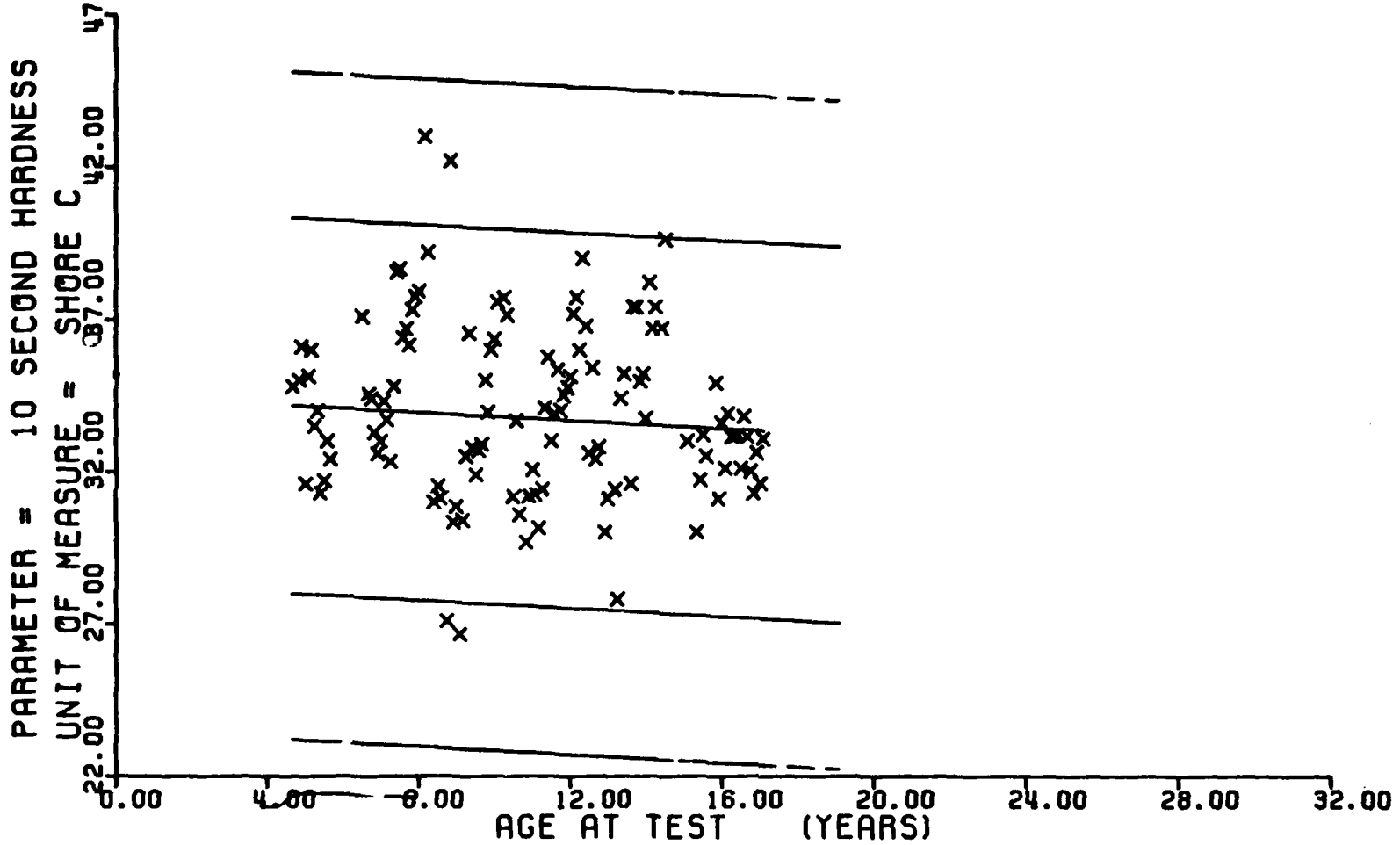
F = +5.1275630E+00 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +3.6594642E+00

R = -6.1718078E-02 SIGNIFICANCE OF R = SIGNIFICANT S_B = +2.4936771E-03

t = +2.2644122E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +3.6538495E+00

N = 1343 DEGREES OF FREEDOM = 1341

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 2 TP-H1043, HARDNESS SHORE C, 10-SECOND

Figure 27

Y = ((+4.1881612E+01) + (-6.3309273E-02) * X)

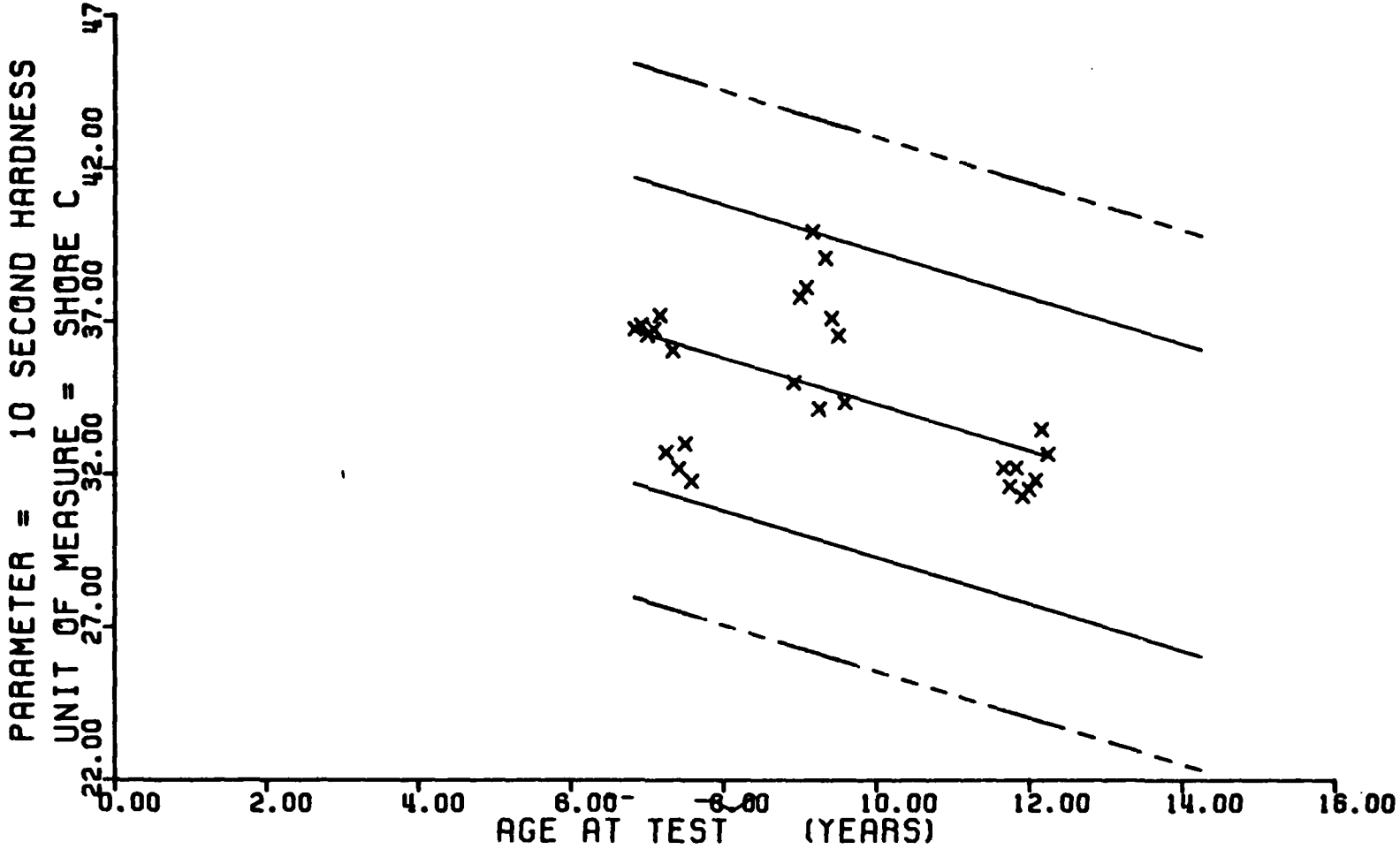
F = +1.5669372E+02 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +3.3088612E+00

R = -4.7803612E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +5.0575656E-03

t = +1.2517736E+01 SIGNIFICANCE OF t = SIGNIFICANT S_E = +2.9090514E+00

N = 531 DEGREES OF FREEDOM = 529

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, WING 6, TP-H1043, HARDNESS SHORE C, 10-SECOND

Figure 28

TABLE 15

ANALYSIS OF COVARIANCE
COMPARISON OF REGRESSION LINES

ANALYSIS OF COVARIANCE(CO-PARES REGRESSIONS,DIMZ/0,TP=FIGH,HARMONESS SH=0.10.EE

SOURCE	D.F.	CORRECTED SUM SQUARES SUM XX	SUM XY	SUM YY	REGRESSION COEFFICIENTS	D.F.	DEVIATIONS FROM REGRESSION SUM SQ.	MEAN SQ.
WITHIN								
PRSC16	1342	0.21469E+07	-12123.	17972.	-0.56467E-02	1341	17963.	13.351
PRSC16	530	0.33094E+06	-20345.	5007.7	-0.73309E-01	529	4476.7	8.4626
						1870	22360.	11.968
POOLED	1872	0.2477BE+07	-33066.	22774.	-0.13346E-01	1871	23033.	12.471
				DIFFERENCE BETWEEN SLOPES		1	955.15	955.15
BETWEEN	1	0.2736E+06	-7465.0	250.00				
TOTAL	1873	0.2701BE+07	-40536.	24024.		1872	23416.	
				DIFFERENCE ADJUSTED MEANS		1	83.062	83.062

STEP 1:
COMPARISON BETWEEN RESIDUAL VARIANCES : F= 1.561(DF=1341, 529) STATISTICALLY DIFF.
IF HOMOGENEITY OF RESIDUAL VARIANCES IS TRUE CONTINUE WITH STEP 2.

STEP 2:
COMPARISON OF REGRESSION FIELD LINE SLOPES : F= 79.74(DF= 1,1870) STATISTICALLY DIFF.
COMPARISON OF FITTED TREND LINE ELEVATIONS : F= 6.66(DF= 1,1871) STATISTICALLY DIFF.

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Solid Propellant
Minuteman
Aft Closure

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report contains propellant test results from cartons of TP-H1043 propellant representing selected batches used in the aft closure of First Stage Minuteman Motors. Data from TP-H1043 propellant obtained from the aft closures of the LGM-30 A, B, F, and G Motors are reported in regression analyses for the sixth time and the fifth time using the G085 Computer System. In previous reports, A, B, F, and G data were combined for statistical analysis. For this report, a separate statistical analysis was made for A and B (wing 2) and

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F and G (wing 6). The statistical analysis includes regressions and covariance analysis. Testing was accomplished in accordance with MMWRBA Project M8293C.

An analysis of all parameters indicate that no significant degradation is anticipated for at least two years past the oldest data point.

Each point on the regression plot represents all samples at that particular age. The number of samples at each point is indicated on the sample size summary sheet on the page accompanying each regression or group of regression plots. The data range at any age can be found by suitable inquiry of the G085 system.

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